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CONTENTS OF VOLUME X.

PAGE.

Art. I.—The Burbung of the Darkinung Tribes. By R. H. Mathews. 1

II.—Victorian Graptolites. Part I. By T. S. Hall, M.A. 13

III.—An Account of the Engwurra or Fire Ceremony of Certain Central Australian Tribes. By Professor Baldwin Spencer, M.A., and F. J. Gillen (Abstract) 17

IV.—The Wandarral of the Richmond and Clarence River Tribes. By R. H. Mathews 29

V.—Geology of the Lower Moorabool. By T. S. Hall, M.A., and G. B. Pritchard. (Plates I. and II.) 43

VI.—Note on a Tooth of Palorchestes from Beaumaris. By T. S. Hall M.A., and G. B. Pritchard ... 57

VII.—The Geology of Coimaidai. Part I. By Graham Officer, B.Sc., and Evelyn G. Hogg, M.A. ... 60

VIII.—The Spectra of the Alkalies and their Atomic Weights. By L. Rummel 75

ART. I.—*The Burbung of the Darkinung Tribes.*

By R. H. MATHEWS,

Licensed Surveyor.

[Read 11th March, 1897.]

Introductory.—The initiation ceremonies described in this article represent those practised by the aboriginal tribes spread over the coastal district of New South Wales, from Newcastle southerly to about Sydney, comprising approximately the Counties of Northumberland, Hunter, Cook, and the greater part of the County of Cumberland. One of the principal dialects was the Darkinung, which was spoken by the tribes occupying the country on the southern side of the Hunter River, from Jerry's Plains downwards towards Maitland, extending southerly to Wollombi Brook, Putty Creek, and including the Macdonald, Colo, and Hawkesbury Rivers. Amongst other dialects employed within the boundaries indicated may be mentioned the Wannungine, and Darrook; but it is probable that in former times there were others of less importance, which have entirely disappeared at the present day.

A small remnant of the Darkinung Tribe, numbering about sixty persons—men, women, and children—are at present located on a Government Reserve on the left bank of the Hawkesbury River, about twelve miles below Windsor, and consist chiefly of half-castes. There are now only two initiated men surviving in this tribe—Joe Gooburra, a pure black, and Charley Clark, a half-caste—both being old and infirm, and likely to pass away at any time. It was from these two old men, with whom I have been acquainted for some years, that I obtained the particulars given in the following pages.

The Main Camp and Burbung Ground.—The locality selected for the gathering of the tribes is in some place where there is a good camping ground, with plenty of water for camp use, and also where native game is numerous enough to provide food for the people. The local mob are of course the first to occupy the ground, and the several tribes who subsequently arrive pitch their respective camps around the former, following the invariable rule of each mob camping on the side facing their own country.

In a convenient place, in close proximity to the main encampment, a circular space, called the *gooraboolan*, was cleared, and the surface soil scraped off in making it level was used to form an embankment around it. A narrow pathway, formed by clearing the ground and scraping the surface smooth, led from this circle to another of somewhat smaller dimensions, bounded by a similar raised earthen wall. The distance between these two circles depended on the character of the ground; if the space between them was scrubby, or some high ground intervened, the distance might not be greater than a quarter-of-a-mile, but if the country was open and flat, the distance from one circle to the other might be half-a-mile or more. The track entered both these circles through an opening, about three feet wide, left in the embankment for the purpose.

Inside the farther ring were a few posts, about four feet high, prepared in the following manner. Some straight saplings, about three or four inches in diameter, were cut in lengths of about five feet, and the bark taken off them. Holes were then dug in the floor of the ring, about a foot deep, into which the posts were inserted, and rammed to make them firm. Sometimes there were only two of these stumps, on other occasions three, and on others four; their number being regulated by the number of "doctors," or clever men, who were expected to perform feats of bringing substances out of their bodies while standing in the ring. At the base of each post a white stone (*ngooyar*) was laid on the ground, and a string (*birrawun*) was stretched from the top of each post to the top of the one next it. Several blackfellows gathered round a *coolamin*, and the head man made a small cut in the arms of each; they then held their hand over the coolamin into which the blood flowed from the wounds. The blood thus collected was rubbed on the stumps erected inside the ring, and the coolamin containing the remainder of the blood was disposed of in the way stated in the next paragraph.

A short distance from the circle was a colossal representation of Dhurramoolun, lying prone on his back, formed of the loose earth heaped up in high relief, and having a quartz crystal (*ngooyar*) laid on his forehead. A little way further was another raised image, also lying on the back, but of smaller dimensions, with the *coolamin* containing human blood, already referred to, lying on his breast. This represented *Ghindaring*, a malevolent being whose body is red and resembles burning coals; he is said to have his abode in rocky places on the tops of mountains. There was another human figure lying near these, about life size, and formed in the same way. The surface of the ground on both sides of the track near these images was ornamented with the usual *yammunyamun* devices cut into the soil, mentioned by me in other publications.[1] Among these carvings may be mentioned a porcupine, a dog, the sun with rays, and the moon both in the crescent and at the full.

Scattered here and there around the circle and amongst the images and designs on the ground were a number of marked trees, on the bark of which were carved representations of the emu, the wombat, the opossum, the kangaroo, the "iguana," the "squirrel," a snake crawling up, and other figures. On a log, which was lying on the ground near by, was cut the figure of a turtle, representing a habit which that animal has of lying on a log on the bank of a water-hole. One of the trees had a narrow strip of bark cut off along its bole in a wavy line, extending from about twenty feet high to the ground, to represent a tree struck by lightning, such as one often sees in travelling through the bush. Another tree had an imitation of an eagle-hawk's nest, built in a fork of one of the branches, about twenty-five or thirty feet from the ground. My native informants told me that the figures of animals and other devices carved on the trees and on the ground were executed with pieces of hard wood on which a sharp edge had been formed. Close to the smaller circle and the raised images a fire was kept burning on top of a low heap of loose earth raked together for the purpose.

Gathering the Tribes.—Messengers were despatched to the head men of all the adjacent tribes who were expected to participate in the ceremonies. Each of these messengers carried the usual emblems of his mission, namely, a bullroarer, a belt, several "tails," or kilts, and his conduct on arrival at a strange camp was practically the same as previously described by me in the initiation ceremonies of other tribes. The messenger remained with the tribe to which he had been sent until they were ready to accompany him to the appointed meeting place. On getting near the general camp, all the men painted their bodies with stripes and patches and coloured clays and the novices were painted red. On arriving in sight of the camp all their baggage was laid down, and the women and aged people remained there for the present. The men then formed into single file, each man having a small green bough in his right hand, and a bundle of spears in his left, the upper ends of which pointed outwards over his left shoulder.[1] The messenger was in the lead, or close to it, and carried the sacred bullroarer in his belt, wrapped carefully in a piece of the skin of some animal.

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[1] Journ. Anthop. Inst., xxv., 302 and 323.

When the strangers reach the ring (*gooraboolan*) they enter it through the opening in the embankment and march round until they are all within it, and then call out the names of remarkable mountains, water-holes, and camping places in their country. They also shout out the names of the wattle trees several times. The local mob, and all the men who had arrived in previous contingents, are sitting round the ring, having assembled there when they heard the strangers approaching. They also now enter the circle, and jump about, and in turn call out the names of wattle trees, mountains, etc., in their several districts. Everyone then comes out of the circle, and the men of the newly arrived mob go and assist their women to put up their quarters on the side of the camp facing their own country. All the men then proceed along the path to the farther ring, the hosts being in the lead. They show the strangers Dhurramoolun and the other images, the marked trees, and everything on the sacred ground, at all of which the men give a shout in unison. They then all return along the path to the public ring, where they again call out principal water-holes, totems, etc., after which they disperse to their several camps.

Daily Performances at the Camp.—Some of the men and women go out hunting and fishing, and searching for roots in different directions every day, returning to the camp at various times, according to their success in the field. Most of the men are back in the camp a few hours before sundown, and go through certain daily preliminary performances. The men of the local tribe gather up out of their camp and proceed to the large ring, carrying a small bough in one hand. The men of the other tribes follow them, and when all the men are in the ring they call out the names of remarkable places in their several districts. During this time the women are beating their hands on their rugs and singing. The men then come out of the ring and throw away their boughs and march away along the pathway to the farther ring, looking at all the imagery on the ground and on the trees. There are generally some of the "doctors," or "wizards," present, and these go into the ring and stand beside the stumps, bringing pieces of string (*birrawun*), quartz crystals (*ngooyar*), and other substances out of their mouths, from their navel, and from between their legs. All the men then return along the path to the public ring, in which they jump about and call out the names of remarkable places as before, after which they walk away to their camps. The bullroarer is sounded in the vicinity of the main encampment every day at dawn and at dusk, and during almost every fine evening a corroboree is danced by one of the tribes present.

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[1] "The Burbung of the Wiradthuri Tribes," Journ. Anthrop. Inst., xxv., 305.

Taking away the Novices.—When all the tribes who are expected have arrived, the old men meet adjacent to the camp, and fix the day on which the business of the meeting—the initiation ceremonies—shall commence. Shortly after nightfall, they proceed to the sacred ground and light pieces of dry bark at the fire burning there, and then come marching back towards the camp shouting and waving their firebrands in the air. They enter the public ring and dance round, the women beating time for them, after which they throw away the firesticks and call out the names of water-holes, etc., and then go away to their camps.

Early next morning the novices are brought into the ring and placed sitting down on the bank, their mothers and the other women being outside. One of the head men then enters the ring and sticks a spear into the ground near one side. He throws the spear out of his hand, and he may have to throw it two or three times before it sticks firmly into the ground. He now catches the spear in his right hand, and another man catches hold of his left, a third man catches the left hand of the second man, and so on all round the ring, until the last man can catch the right hand of the man who holds the spear. The first man thereupon relinquishes his hold of the spear, which is a signal for all the men to let go each others' hands. An old man then goes round the ring and hits the ground with his *nulla nulla*, and all the men fall down. In a short time they rise again from the ground and withdraw to the side of the ring where the track enters it. The boys' heads are now bent down, and the women are covered with rugs, bushes or grass, some of the old men being deputed to watch them. As soon as this is done two men sound bullroarers (*minyawoak*) in close proximity, whilst the other men beat their weapons together, and the man who has been appointed guardian to the novice, usually his brother-in-law, now catches him by the arm and leads him away along the pathway. On reaching the farther ring the novices are shown the carvings on the turf and on the trees, the eagle-hawk's nest, the lightning tree, etc. They are next shown Dhurramoolun and Ghindaring, and lastly the blood-stained posts, with the white stones and string. The posts are then pulled out of the ground and burnt upon the fire.

The Watyoor Camp.—A short digression must now be made for the purpose of explaining how the women are released from the custody in which they were left when the novices were taken away. Shortly after the latter get out of sight the covering is removed from the women by the old men who have charge of them, and they are set at liberty. All hands then gather up their baggage and remove the camp to another locality, perhaps some miles distant, which was determined by the head men at the same time that they fixed the day for taking the boys away. On arriving at the new site the local mob are the first to erect their quarters, around which the visiting tribes take up their positions on the sides which are nearest their respective districts. Several old men, some belonging to each tribe, remain with the women at this new camp for the purpose of superintending the due performance of all the tribal regulations.

About a hundred yards from the main encampment—on the side towards that part of the hunting grounds into which the novices have been taken—the old women, and mothers of the boys, erect a gunyah, called the *watyoor*, composed of forked saplings, rails and boughs. It is built in a straight line, and is open on the side facing the direction from which the novices will approach it, in the manner described later on. It is large enough to hold all the novices and their guardians, and has leaves strewn thickly on the floor for them to lie on. Near one end of this long gunyah all loose rubbish is cleared off the surface of the ground to make it fit for dancing on. Every morning the mothers of the novices, accompanied by the old women of all the tribes present, repair to the *watjoor*, and light one or more fires in the cleared space, around which they sit and sing songs which have reference to the novices. Every night they dance at these fires, from which they lift burning sticks and wave them in the air, in the direction in which they believe the boys to be camped with the headmen. These women are collectively known as *yanniwa*, and the young women or children, or any of the men, are not permitted to go near them when assembled at the *watjoor*.

Ceremonies in the Bush.—We must now return to the novices at the sacred circle. When all the formalities have been carried out, the men and boys start away to the part of the district in which it has been decided to remain whilst carrying out the ceremonies in the bush. All the men who take part in the secret ceremonies, who are called *Kooringal*, have their bodies painted jet black, with powdered charcoal and grease. The novices walk with their guardians, their heads being inclined on their breasts, and when the camping place is reached, they are placed sitting down on leaves spread thickly on the ground, their backs being towards the men's quarters. Several days may be spent at this camp, or perhaps a fresh camping place is reached every night. In either case, various spectacular displays, representing animals, hunting scenes, and also songs and dances, take place every fine evening at the camp fires. The time spent at these camps in the bush generally occupies about a fortnight, being regulated by the weather and other considerations. Human ordure is occasionally given to the novices in addition to their daily food. They are not allowed to speak to anyone, and if they require anything they must make a sign to the guardian who has charge of them.

About the middle of this period, preparations are made for the extraction of one of the novice's upper incisor teeth. A small patch of ground is cleared of all loose rubbish a short distance from the camp, and the guardians raise the novices on their shoulders and carry them thither. In this clear space, which is called the *bunnumbeal*, some men are seated, beating the ground in front of them with pieces of bark, shaped something like a cricket bat, and making a noise. The father or uncle licked or sucked the top of the novice's skull, for the purpose of making the tooth come out more easily. One man then bent down, and placed the boy sitting on his knee, another man standing beside him to keep the boy steady. The tooth extractor then stepped forward, and inserted his own lower teeth under one of the boy's upper incisors, and gave a strong steady pull, which perhaps brought out the tooth. If this failed, a small piece of wood, hardened in the fire, was used as a chisel, being placed against the tooth, and then a smart tap with a mallet on the other end completed the dental operation. The tooth was then taken out of the boy's mouth with the man's fingers, and held up to public view, which was the signal for a shout from all the men present. During these proceedings a bullroarer was sounded in the adjacent bush, just out of sight, and at the conclusion the boys were led back to their camp, and put sitting down with their hands over their mouths. They must swallow the blood which flows from the wounded gum. During their stay in the bush each boy has the hair of his head cut off, which is twisted into a coil, "like a fig of tobacco," as my native informants said. A male relative of the boy keeps this coil of hair for a long time.

In the course of a day or two after the extraction of the tooth, some men come from the *watyoor*, or women's camp, and approach the Kooringal's quarters, uttering a weird noise, something between a shout and a whistle. Each man carries a long, slender, bushy bough, holding one end of it in each hand, with the middle part bent over his head like a wreath. These men come right up to the camp and jump about in front of the boys, who are allowed to raise their eyes and look at them. The strangers then throw down their boughs and go a little way from the camp, where they enter into conversation with the head men of the Kooringal. They inquire how the initiation ceremonies are progressing, and arrange the date of the return of the novices to the *watyoor*, after which they take their departure and go back to the camp of the women, and inform them when the boys may be expected.

Early on the following morning the novices are placed standing in a row beside the camp with their eyes cast down upon the ground. The men then stoop down and scratch the loose leaves off the surface of the ground until an oval space has been cleared. Some of them then stand round on this cleared space, into which two men enter and commence swinging the bullroarers (*minyawoak*), and the boys are told to look at them. Some armed men now rush up to each of the novices and caution them against revealing what they have been taught during their sojourn in the bush. After this everything is packed up and the journey towards the *watyoor* camp commenced. On arriving at a water-hole, which had been decided upon by the head men at the same time that the position of the *watyoor* was determined, the Kooringal jump into the water, under the pretence of looking for turtles, but in reality for the purpose of washing off the charcoal powder with which their bodies were painted. The novices do not go into the water-hole, but stand on the bank watching the men, who lave handfuls of water towards them. When the men come out of the water-hole they paint their bodies all over with pipe-clay, and the novices are painted with stripes or daubs of white on the face, arms, and chest. The men and boys are dressed in their kilts and other regalia and the journey onwards towards the women's camp is then resumed.

Return of the Novices.—On the day which has been appointed for the return of the novices their mothers proceed to the *watyoor*, being painted with coloured clays. They wear headbands round their hair, in which are fastened various ornaments, such as the feet of the porcupine (*Echidna*), the teeth of animals, and the tail of the native dog hanging down behind. They are accompanied as usual by the other old women of the tribes present, and on this occasion several old men go with them to make the necessary arrangements for the reception of the novices. These old men take the yam-sticks of the mothers and insert them in the ground all along the open side of the *watyoor*, the top of each stick having a bunch of leaves tied to it, and also some article belonging to the owner attached to it, in order that each boy may recognise his mother's yam-stick.

All the necessary preparations having been made, a signal is given by the men, on which the Kooringal and neophytes make their appearance marching in file, the latter being near the front. The women are dancing and jumping around a fire on the clear space near the *watyoor*, and when the contingent from the bush get near enough the women go a little way towards them, and throw small pieces of bark over the men's heads. These pieces of bark are prepared for the purpose, being about the size of a man's open hand. They are first slightly charred in the fire, and are then ornamented with a few stripes or daubs of pipe-clay. Several of these missiles are thrown by each woman, and are warded off by the men. The novices march right on into the *watyoor*, and each boy lies down on the leaves opposite his mother's yam-stick, their guardian's remaining in front of them. The mother's now go back to the main camp, which is perhaps 100 or 200 yards away. The men then throw green bushes on the fire, around which they gather until the old men consider that they have been sufficiently fumigated. After this the Kooringal go into the women's camp or into the single men's quarters, but the guardians remain with the novices who camp at the *watyoor* that night.

Next morning the guardians and novices leave the *watyoor* and go into the bush for some days, gaining their living by hunting. During the day the people at the main camp proceed to settle any tribal wrongs which may have been perpetrated since the last initiation gathering A few of the men of each side throw spears and other weapons. Some of the women of one tribe engage in combat with women of another tribe, using their yam-sticks freely on their opponents. When their differences are satisfactorily disposed of in accordance with tribal custom, all the people seem to be again on the best of terms with each other.

In the course of a few days the novices are again brought back to a place near the women's camp, painted and wearing their full dress. Pieces of bark or rugs are spread upon the ground, on top of which each mother lays some food for her son. Two "dilly bags," containing leaves, are laid beside each boy's allowance of food, and the mothers and old women remain close by, painted and dressed as on the occasion of the return of the novices to the *watyoor*. When everything is ready the guardians bring the novices marching up, and on their arrival each boy picks up one of the dilly bags and pulling the leaves out scatters them in the air. Then they each lift the other bags of leaves and scatter them in the same manner, after which they sit down and commence eating the food. The mothers then come forward and sit down beside their sons, and sing a kind of lamentation, because from this time onward the boys will not be permitted to stop at their mother's camp, but must remain with the men. At the conclusion of their repast the novices are taken into a camp provided for them near that of the single men, and the mothers return to their own quarters.

The ceremonies being now at an end, all the strange tribes get ready for their departure to their respective countries, and in the course of a few days most of them are on their way homewards. Each tribe take care of their own novices, who are still kept under the control of their guardians after their return to their own country. They now go out hunting with the men during the day, and are brought a little nearer the camp every night, until they are at last brought right into the single men's quarters. The novices are now called *Narramang*, and rank as men of the tribe. They must, however, abstain from eating certain animals and other kinds of food which have been enumerated to them by the chief men of their tribe.

Owing to the novices having to keep their heads bent down, and being otherwise prevented from seeing many parts of the ceremonies it becomes necessary that they should attend at least one more Burbung before they can become thoroughly acquainted with the different parts of the ceremonial. At the next gathering of the tribes for initiation purposes, the neophytes who have passed through the ordeal described in this article will be allowed to assist in preparing the sacred ground, and be present at the arrival of the tribes, and also to attend all the private meetings of the men. They will likewise be permitted to join the Kooringal, and see everything that is done at the secret camps in the bush and at the *watyoor.*

On the north the Darkinung are bounded by the Wattung and other tribes scattered over the country on the other side of the Hunter River; on the west they are joined by the great Wiradjuri community, and their limits on the south are identical with the boundary of the people occupying the south-east coastal district of New South Wales. The south-east corner of the *taorai* of the Kamilaroi Tribes touched the north-west corner of the Darkinung territory about Jerry's Plains. On carefully studying the initiatory rites of the tribes referred to, as described by me elsewhere, traces of all their ceremonies are distinguishable in the Burbung of the Darkinung tribes. This is only what I should expect to find among a people surrounded by powerful communities, speaking different languages, and having initiation ceremonies more or less divergent.

ART. II.—*Victorian Graptolites.*

PART I.

(*a*) ORDOVICIAN FROM MATLOCK.
(*b*) DICTYONEMA MACGILLIVRAYI, nom. mut.

By T. S. HALL, M.A.,

Demonstrator and Assistant Lecturer in Biology in the
University of Melbourne.

[Read 13th May, 1897.]

(*a*) ORDOVICIAN FROM MATLOCK.

The small collection of graptolites, which is dealt with in the present communication, was made by Mr. E. O. Thiele during the Christmas vacation, and was kindly placed in my hands for examination through the agency of Mr. G. B. Pritchard.

The fossils occur in a black, earthy slate in which cleavage is but slightly developed at a very small angle to the bedding plane. They are preserved in a silvery white mineral, and though they thus stand out with remarkable distinctness on the dark background, yet the details of their structure are in most cases entirely wanting, so that specific determinations are not possible, except in the case of one species.

The commonest forms are clearly referable to the genus *Dicellograptus.* These occur in great profusion, being fairly matted together on some of the slabs. In no instance are the hydrothecæ shown with sufficient clearness to enable their form to be fully made out, or for counting. One or two examples have the habit and size of *Dicellograptus morrisii*, Hopk., approaching more nearly to Hopkinson's figure[1] than to that given by Lapworth.[2] The sicula is clearly shown, and the lateral spines can be made out in some of the specimens. What is another species, apparently, has its branches diverging at an angle of about 40° and quite straight, measuring, in one instance, more than 5mm. in length. In some places the slabs are crowded with a great number of young examples of the same genus, showing the sicula and three spines very clearly at times, but in no case is the outline of the hydrothecæ visible.

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[1] Geol. Mag. viii., 1871, pl. i., f. 2a.

[2] Proc. Belfast Nat. Field Club, 1876-7, Appendix, pl. vii., f. 6.

The only other forms present are Diplograptidæ. Only one of these am I able to determine specifically. This is *Diplograptus foliaceus*, Murch. About half a dozen specimens occur. The hydrophyton is about one-and-a-half inches long and one-eighth inch broad, parallel sided for the greater part of its length and gradually tapering towards the proximal end, which is imperfect in all the specimens. The virgula is not visible. Hydrothecæ about twenty-five to the inch, and having the form shown by Hopkinson and Lapworth in two of their figures.[1]

There are two other species of *Diplograptus* which I am unable to determine with certainty.

The family Dicranograptidæ to which *Dicellograptus* belongs is, according to Lapworth, confined to the Upper Ordovician.[2] *Diplograptus foliaceus*, though not having exactly the same range, is associated with Dicranograptidæ in Britain, and I have identified the same species as occurring rarely at Darriwill. The beds at the latter place I previously placed tentatively on the horizon of the *Loganograptus* zone at Castlemaine.[3] Since then Mr. Pritchard and myself have paid two visits to Wilkinson's locality at Darriwill,[4] and from an examination of the fauna I am inclined to refer it to a slightly higher position than I did previously, though Dicranograptidæ have not been observed.

The only other fossil recorded from Mount Matlock is *Cardium gippslandicum*, M'Coy. This is also recorded from Russell's Creek, Gippsland, by Sir Frederick M'Coy, in association with *Orthoceras striato-punctatum*, Münst.[5] This association induces Sir Frederick to refer the beds containing the *Cardium* to the (Upper) Silurian.

The occurrence of Ordovician fossils at Matlock is consequently of considerable interest and indicates the presence of an inlier in the heart of what is mapped as (Upper) Silurian country. With regard to the extent of these lower rocks and the nature of their contact with the younger series we have as yet no knowledge, and as the matrix of the Museum specimen of *Cardium gippslandicum* from Matlock is very similar to that of the graptolites before me, great care will have to be exercised in mapping the area.

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[1] Q.J.G.S. xxxi., 1875, pl. xxxv., figs. 7*e*, 7*g*.

[2] A.M.N.H. 5, vi., 1880, p. 21.

[3] Proc. Roy. Soc. Vic., viii. (N.S.), 1894, p. 76.

[4] W.L.S., 1, of Quarter Sheet 19, S.W.

[5] Geol. Surv. Vict., Progress Report, vi., 1880, p. 71.

The horizon of the present fossils is very close to that indicated by the graptolites which I recently recorded from North-eastern Victoria, and is referable to the upper part of the Ordovician.

Locality.—Four miles from Matlock, on the Wood's Point Road (E. O. Thiele).

(*b*) DICTYONEMA MACGILLIVRAYI, nom. mut.

Some years ago I described and figured this species under the name of *D. grande*,[1] and two years later Mr. G. B. Pritchard described the hydrothecæ of the same species.[2] According to Bigsby[3] the name had previously been used by Barrande, but Jahn says only in manuscript if used by Barrande at all.[4] Since then the name has been applied by Nicholson to a Canadian form.[5]

The present species is distinct from Nicholson's, and I propose the name *D. macgillivrayi* for it, dedicating it to the late Dr. P. H. Macgillivray, whose labours in our recent and tertiary polyzoa are so well known.

It is of interest to note that the genus *Bryograptus* occurs commonly at Lancefield in association with this species, having been simultaneously recognised by Mr. Pritchard, and myself. The presence of this fossil satisfactorily confirms the relative position I had assigned to the beds, as containing the oldest graptolite fauna we know in Australia, Professor Lapworth regarding the genus as Upper Cambrian.[6]

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[1] Proc. Roy. Soc. Vic., iv. (N.S.), Pt. I., 1892, p. 6.

[2] Proc. Roy. Soc. Vic., vi. (N.S.), p. 28.

[3] Thes. Silur., p. 200.

[4] Sitz. d. K.K. Akad. d. Wiss. Wien, Bd. CI., Heft. vii., Ab. I., p. 642.

[5] A.M.N.H., 4, xi., 1873, p. 133.

[6] A.M.N.H., 5, v., 1880, p. 274.

Mr. J. E. Marr[1] classes all the zones of *Bryograptus* as of Tremadoc age, and in a letter he tells me that he considers the genus to be confined to the Tremadoc. Mr. R. Etheridge, jun., has already recorded Cambrian rocks from Victoria,[2] and his locality, Heathcote, is due north of Lancefield and approximately on the same strike, though the stratified palæozoic rocks of the two districts are separated from one another by the, presumably intrusive, granite of the Baynton Range. Selwyn[3] says that "Victorian palæozoic physical geology in its broadest features may be represented as consisting of a great . . . sinclinal trough of lower palæozoic (silurian) and older strata." I have previously given reasons for considering the rocks of N.E. Victoria to be of Upper Ordovician age.[4] Our knowledge of the fauna of the Palæozoic rocks west of Ballarat is as complete a blank to-day as it was when Selwyn wrote thirty years ago. The presence of Cambrian rocks on the meridian of Melbourne shows the existence of an axial line of elevation, with this peculiarity, that there is, as far as our present limited observations go, a descent in the exposed rocks as we pass northward. The recorded graptolites from near Bulla are Upper Ordovician, those of Lancefield are apparently of Tremadoc age, while, according to Mr. Etheridge, the small outcrop at Heathcote is probably Middle Cambrian. Whether this is due to the transverse folding which produced our Dividing Range, and, perhaps, also the remarkable "pitch" of our older rocks, is a question of great interest, but one which must rest till more data are available.

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[1] Science Progress, July, 1896, pp. 360-74.

[2] Proc. Roy. Soc. Vic. viii., (N.S.), 1895, p. 52.

[3] Vic. Internat. Exhibit. Essays, 1867, p. 9.

[4] Proc. Roy. Soc. Vic., ix., (N.S.), 1896, p. 183.

Art. III.—*An Account of the Engwurra or Fire Ceremony of Certain Central Australian Tribes.*

By Professor Baldwin Spencer, M.A.,

and

F. J. Gillen,

Special Magistrate and Sub-Protector of Aborigines, Alice Springs.

[Read 8th April, 1897.]

(Abstract).

Amongst certain Central Australian tribes the last of the initiatory rites through which a man must pass before he is admitted to full membership takes the form of what may be called a series of ordeals by fire.

Such a fire ordeal has not hitherto been described so far as we are aware amongst Australian natives, and, during the recent summer, the authors had the opportunity of witnessing the Engwurra ceremony as enacted by the natives of the Arunta tribe living in the Macdonnell Ranges in the centre of the continent. Similar ceremonies are known to the authors as occurring in other tribes, such as the Ilparra and Warramunga, whilst a slightly different one called the Wilyaru occurs amongst the Urrabunna tribe. Of considerably greater importance however than that referring to the fire ceremonies themselves, which only occupied a comparatively short time, was the information which the authors were enabled to collect with regard to the organisation of the tribe in respect to the existence and curious arrangement of the totems, and also in regard to the meaning and significance of the churinga or sacred sticks and stones of the natives.

Before entering into details it is necessary to refer briefly to the organisation of two tribes which may be taken as typical examples, one in which descent is counted in the female and the other in the male line.

Of the former we may take the Urrabunna, living to the west of Lake Eyre, as an example. In this the whole tribe is divided into two exogamous intermarrying divisions, each of which we will speak of as a phratry. One of these is called Matthurrie and the other Kirarawa. A Matthurrie man must marry a Kirarawa woman, and his children are Kirarawa, that is, they belong to the mother's moiety. In addition to the phratry name, each individual bears a totem name, that is, he or she is a member of a group of individuals—the whole group being distributed in various localities over the district occupied by the tribe—who are supposed to be especially associated with some animal or plant, the name of which they bear. Each of these groups is called by the natives a Thunthunnie, and no man or woman may eat the animal or plant associated with his or her own totem or Thunthunnie. Further still, there are particular totems restricted to the two phratries, and by means of them further restrictions are placed upon marriage—a Matthurrie man of one totem having to marry a Kirarawa woman of another totem. A few of these and the marriage relationship is shown in the following table :—

Man.			Woman.		Children are	
Phratry.	Totem.		Phratry.	Totem.	Phratry.	Totem.
Matthurrie	Cicada,	marries,	Kirarawa	Crow,	Kirarawa	Crow.
,,	Dingo	,,	,,	Waterhen	,,	Waterhen.
,,	Emu	,,	,,	Rat	,,	Rat.
,,	Swan	,,	,,	Pelican	,,	Pelican.

This shows at once that both as regards phratry and totem the children follow the mother.

Taking now the Arunta tribe[1] we may describe its organisation in outline as follows. There are four subphratries so coupled together as to give clear evidence of the former existence of two main phratries. These four subphratries are called Panunga and Bultharra, Purula and Kumarra. Panunga and Bultharra represent one moiety or phratry, Purula and Kumarra the other. Further reference will be made to this point later on. We can tabulate the marriage arrangements as follows :

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[1] The Urrabunna tribe is practically identical in organisation with that described by Mr. Howitt as occurring in the adjoining Dieri tribe, and the organisation of the Arunta tribe has already been, to a certain extent, described by Messrs. Fison, Howitt, Stirling, and Gillen.

Man.		Woman.	Children are
Panunga	marries	Purula -	- Bultharra.
Bultharra	,,	Kumarra	- Panunga.
Purula	,,	Panunga -	- Kumarra.
Kumarra	,,	Bultharra	- Purula.

In other words a man must marry a woman belonging to the moiety of the tribe to which he does not belong, and his children belong to his own moiety, but to the other division of it.

As we have said, this is the arrangement in mere outline, practically conditions are more complicated. For example, not all Panunga women are eligible as wives to each and every Panunga man. To a Panunga man the Purula women are divided into two groups (and *vice versâ* if we speak of a Panunga woman), which are called respectively Ipmunna and Unawa, and it is only the latter who are eligible to him as wives, and who are called his tribal unawas, or wives, though he only actually marries a limited number. In this way it will be seen that each subphratry is subdivided into two groups, so that as a matter of fact we actually get eight and not four divisions, and each one of these eight has in the northern part of the tribe a distinct name, four others, viz., Uknaria, Appungerta, Ungalla and Umbitchana being added to those already mentioned. The original Panunga is now divided into Panunga and Uknarria, the Bultharra into Bultharra and Appungerta, the Purula into Purula and Ungalla, and the Kumarra into Kumarra and Umbitchana. With this further division, while matters are, to a certain extent, complicated, yet in other ways they are simplified. In the southern part of the tribe all the women belonging to the division, into which say a Panunga man must marry, are called Purula ; in the northern half of the tribe, half of the original Purula retain the old name, the other half have acquired[1] a new name, viz., Ungalla. In the same way the Panunga has been divided into Panunga and Uknarria. A Panunga must now marry a Purula (that is, a woman belonging to only one-half of the original group of the same name) and an Uknarria marries an Ungalla.

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[1] This division into eight has been gradually adopted from the Ilparra tribe, which inhabits the district immediately to the north of the Arunta. At the present time the division into eight is slowly spreading southwards through the Arunta.

So far as the phratry is concerned the matter of descent is comparatively simple—the child goes into that of its father—but, in the case of the totem, it is at first sight most perplexing. You may, for example, examine first a family in which the father is a witchetty grub and the mother a wild cat, and you may find that, supposing there are two children, both of them are witchetty grubs. In the next family examined, perhaps, both parents will be witchetty grubs, and out of two children one may belong to the same totem and the other may be a wild cat, and so on, the totem names being apparently mixed up in the greatest confusion possible.

The following table gives the actual totem name of two families, selected at random, who are now living amongst the Arunta in the northern part of the tribe, and may be taken as accurately representative of the totem names found in various families throughout the tribe. Of course the names vary much from family to family, and in various parts of the country, certain totems predominating in some parts and others in other parts. You may, perhaps, for example find yourself in one district of more or less limited area and find one particular totem largely represented: travelling out of this district you may find that special totem but seldom present until you come into another and perhaps distant part—it may be forty or fifty miles away—when again it becomes the principal totem. The reason for, or rather the explanation given by the natives of, this curious local distribution of the totems will be seen subsequently.

Family 1.—Father, little hawk. Wife No. 1, bandicoot; daughter, witchetty grub. Wife No. 2, kangaroo; no children. Wife No. 3, lizard; two daughters, one emu, the other water.

Family 2.—Father, witchetty grub. Wife No. 1, lizard; no children. Wife No. 2, Hakea flower; four sons, respectively, witchetty grub, emu, eagle-hawk, Arrakurta; two daughters, each witchetty grub.

Taking these[1] as typical examples, it will be seen that the question of totem has nothing to do with marriage so far as either making it obligatory on a man of one totem to marry a woman of another, or so far as the totems of their children are directly concerned.

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[1] These are only two out of very many examined by the authors.

In their curious totem regulations the Arunta, Luritcha and Ilparra tribes agree, as the authors know from personal observation, whilst they have strong reason to believe that large and important tribes living to the north are in accord with them on all important points. These tribes are the Warramunga, Waagai, Illeowra, and Wickliffe.

It was whilst watching and questioning closely the natives during the performance of the Engwurra ceremony that the authors were able to find out the way in which the totem names of the individuals originate.

The total period occupied by the Engwurra was more than four months. It was held near to Alice Springs and was attended by representatives from various parts of the tribe, some of whom travelled a distance of about two hundred miles to be present. The men were summoned by messengers bearing the sacred churinga, and about the middle of September they began to assemble. A special level piece of ground, somewhat triangular in shape, bounded on one side by a river with its belt of timber, and on another by a range of rugged quartzite hills, and on a third by low scrub, was selected as the spot for the Engwurra ground. The main encampment to which the women and children went was fixed on the opposite side of the river so that no females or uninitiated males could see what was taking place in the Engwurra ground. The component groups of the camp could be distinguished by the spots on which they built their wurlies, those who came from the south erecting them on the south of the ground, those from the north on the north side and so on. Each party which came in brought with it a larger or smaller number of the sacred sticks and stones which are called churinga.

We have already referred to the division of the tribe into two moieties, one consisting of the Panunga and Bultharra men, and the other of the Purula and Kumarra, and in connection with the storing of the churinga on the Engwurra ground this fact was brought out very prominently. All those belonging to the Panunga and Bulthurra were placed on a special platform made in the branches of a mulga tree on the range bounding the southern end of the ground, while those of the Kumarra and Purula were placed on a small platform at the northern end of the ground.

In speaking of one another also, men of the two moieties use different words to describe their own and the other moiety. For example, if you are speaking to a Panunga man he will refer to the Kumarra and Purula as being *Mŭlyanūka*, and to the Panunga and Bultharra as *Nākrăkia*. In just the same way a Kumarra man will call his own moiety *Nākrăkia* and the other *Mŭlyanūka*.

The evenings of the first three weeks were occupied by the performance of two ordinary corrobborees at which all members of the camp, women and children included, were allowed to be present. Before these were concluded the leader of the Engwurra went down to the ground where the ceremonies were to be performed (the ordinary corrobboree ground being some distance away) and here he made a long low mound of earth about forty feet in length, two in width, and one in height, and ornamented the top with small boughs of Eucalyptus. This was called the Parra and apparently is meant to represent a tract of country. By its side the great majority of the ceremonies were enacted. At the end of the three weeks the men who were to be finally initiated, together with the older men, separated themselves from the women who remained in the main camp, and lived on or close by the Engwurra ground for nearly three months. During this period there was a constant succession of sacred ceremonies, all of which were concerned with the totems.

The idea of the whole ceremony was evidently first to test the powers of endurance of the younger men who had implicitly to obey the directions of the older men and secondly to impart to them the sacred secrets of the tribe concerned with the totems and the churinga.

Without going into details it may be said that each of the very numerous separate ceremonies was concerned with a particular totem and further with a totem associated with a particular spot. The native name for these sacred ceremonies is Quabarra[1] and the names of a few will serve as illustrations of the long series. There was for example the Quabarra Unjeamba of Ooroominna which means a ceremony of the Unjeamba or Hakea flower totem of a place called Ooroominna; the Quabarra

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[1] The ordinary corrobboree is called "Altherta" by the Arunta people.

Achilpa of Urapitchera which means a ceremony of the "wild cat"[1] totem of Urapitchera, a place on the Finke River; the Quabarra Okirra of Idracowra which means a ceremony of the kangaroo totem of Idracowra, a place on the Finke River, and the Quabarra Unchichera of Imanda, which means a ceremony of the frog totem of a place called Imanda or the Bad Crossing on the Hugh River.

In this way each ceremony was concerned with some particular totem and not only this but with a totem or rather a special division of a totem of some particular locality, and further still, each ceremony was owned and presided over by some old man, usually, but not always, of the totem and locality with which it was concerned.

By means of enquiring carefully after each performance as to what it represented, the authors were able to gather together a large series of notes relating to the traditions of the tribes in regard to the totems, but, for the present purpose, the following brief outline of the myths or traditions which have sprung up to account for the curious totemic system of the tribe will suffice.

All the ceremonies were concerned with certain mythical ancestors who lived in what the natives call the "alcheringa" or dream times. These ancestors are so intimately associated in the native mind with the animals or plants whose name they bore that an alcheringa man of, say the kangaroo totem, may be spoken of either as a man-kangaroo or as a kangaroo-man. The identity of the human individual appears to be sunk in that of the object with which he is associated and from which he is supposed to have originated.

These alcheringa men and women are represented as collected together in companies, each one of which consisted of a certain number of individuals. The members of each company were of the same totem and belonged to the same moiety of the tribe, that is they were either Purula and Kumarra, or Panunga and Bultharra. In the alcheringa, for example, we meet with traditions referring to several groups of "wild cat" men, most of them composed of Purula and Kumarra but some of Panunga and Bultharra, the kangaroo men seem to have been Purula and

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[1] *i.e., Dasyurus geoffroyi.*

Kumarra, and the witchetty grub men Panunga and Bultharra. At the present day no totem is confined to one moiety of the tribe, but in each "local centre" of a totem we always find a great predominance of members belonging to one half, as for example at Aliçe Springs, the most important centre of the witchetty grub totem, where amongst a large number of Panunga and Bultharra men there are a few Purula and Kumarra.

These alcheringa ancestors are represented in tradition, some of them as originating and staying in certain places, such as the witchetty grubs at Alice Springs, others such as the wild cat groups are represented as wandering about over the country in various directions, but along certain definite lines, the route of which is accurately preserved in tradition.

Every alcheringa man and woman carried about a large number of the sacred churinga,[1] the meaning and significance of which has not previously been known. At certain camping places as the alcheringa ancestors travelled on, or at spots where they originated, certain individuals are represented as having gone into the ground and as having been transformed into sacred churinga. Certain also of the latter were placed in the ground at these camping places.

Each churinga is inseparably associated with a spirit individual —in the case of the individuals who turned into them, the name is even preserved—and so we find at the present day that the whole country occupied by the Arunta is dotted over with numerous spots at each of which numbers of sacred churinga are buried, each of which is associated with a spirit individual. In this way there have been formed what the natives call *ŏknānikĭlla*, that is spots, each of which is, as it were, inhabited by spirit individuals the totem of whom is of course that of the alcheringa individual whom they represent or who carried the churinga with which each one is associated. These oknanikilla may hence be appropriately termed *local totem centres*, and if we take one alcheringa group of ancestors such as the wild cat for example, it will now be seen that we have over the country and also, it must be remembered, in spots well known to the natives, groups of wild cat spirit individuals.

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[1] The form of these, some of which have been figured and described by various writers such as Messrs. Stirling, Gillen, Etheridge, etc., are well illustrated in the Report of the Horn Expedition, vol. iv., pl. 7. Their use as sacred objects has been described by writers such as Messrs. Howitt, Fison and Gillen. They are of the nature of the "bullroarer," the use and importance of which was first pointed out in Australia by Mr. Howitt.

When a woman conceives it is supposed that it is one of such a group of spirits who goes inside her and thus it naturally follows, granting the premises firmly believed in by the natives, that the totem of the child is determined solely by the spot at which the mother conceived, or, what is the same thing, believes that she conceived, the child. A single example of one of numerous actual instances known to the authors must suffice to illustrate the actual usage. Not long ago a witchetty grub woman, living at Alice Springs, her husband belonging to the same totem, went on a visit to a neighbouring emu group, here she conceived, and the child, afterwards born in a witchetty grub locality at Alice Springs, belongs to the emu totem; it *must* do, the natives say, because it entered her in an emu locality; had it entered the mother at Alice Springs it would as inevitably have been born a witchetty grub.

Not only is this so, but every spirit-child, when entering a woman, is supposed to drop the churinga which until then it always carries about. After the child's birth the father and one or two old men, having learnt from the mother where conception took place, actually go in search of the churinga. They either find one, or if they do not, then they manufacture one out of the mulga or other hard wood tree which lies nearest to the spot. At the latter there is usually some gum tree or prominent natural object, such as a rock, which the spirit-child has been supposed to specially inhabit, and this is spoken of as its nānja tree or stone. During the life of the human individual who is its reincarnation this is his nanja tree or stone and the churinga is his churinga nanja.

Each local group of a totem has a sacred store-house, such as a cleft in some more or less inaccessible spot in a rough range, and here, under the custody of the head man, or alārtunja, of the group, all the churinga are kept. No woman or uninitiated man goes near this sacred store-house, or ertnătūlŭnga, under penalty of death.

Such, in brief outline, is the totemic system of the Arunta, Ilparra, and Luritcha tribes, and as before said the same probably applies with slight variations to tribes further north.

The greater part of the Engwurra was occupied with performing these sacred ceremonies of the totems, whereby a knowledge of the doings of the alcheringa ancestors was communicated to the younger men, and the sacred churinga some of which belonged to them, others to more recent ancestors and others to still living individuals, were carefully examined and explained.

After about three months, during which time the younger men had been living mainly in the Engwurra camp, an important change in the proceedings took place. The young men were, in parties of three and four, put under the charge of certain of the older men who had already been through the ceremony and received collectively the name of *Ilpongwurra*, a word which implies an absence of certain forms of decoration, such as grease, and had their foreheads and the hole through the nasal septum decorated with twigs of a particular species of Eremophila. Between each young man and the elder man in charge of him the relationship of *Apmūrra* was established, that is, the young man might not speak to, or in the presence of, the older one.

Daily, just at sunrise, the Ilpongwurra were sent in a body out of the Engwurra camp under charge of two or three old men and to the accompaniment of the loud whirring and booming of churinga or bullroarers. It was now their duty to remain out in the bush securing food for the old men, to whom it was brought in at night time.

Now also began the fire ordeals which were of three forms. The first took place in the main women's camp at sunrise or sunset or both. All the Bultharra and Panunga women in one spot and all the Purula and Kumarra in another, gathered together and, each party having made a fire, awaited the approach of the Ilpongwurra, who were driven towards them in a body by older men, protecting themselves as well as they could with shields and boughs of Eremophila from the burning grass and boughs which the women threw over their heads.

After having been thus treated by each group of women separately, the Ilpongwurra turned and fled to the Engwurra camp, near to which the women, of course, dare not come.

The second fire ordeal took place out in the bush, and was repeated on two separate days. The older men made a large hot fire in a secluded spot amongst the ranges, and having placed green boughs on the red-hot embers made the young men lie down upon it, each one for perhaps three or four minutes, in the stifling smoke and heat. This was undoubtedly, as the authors can testify after trying the heat of the fire, at all events a very unpleasant and rather severe ordeal.

The third was less severe and will be described shortly.

While the Ilpongwurra were out of camp the old men still went on performing ceremonies, reserving many of them, however, for night-time, when, specially towards the end, there was little rest to be had. Singing and ceremonies went on with little intermission, often till two or three o'clock in the morning. The ceremonies, though it is not necessary to describe them here, were, it must be remembered, such as required elaborate preparation in the way of decorating the performers, and often occupied in this way from three to six hours.

Two days before the last ceremony was performed, under the direction of the old man who had been in supreme charge throughout, a small gum tree about twenty feet in height was cut down and carried into camp. After being smeared all over with human blood and having had the upper end decorated with a tuft of eagle-hawk feathers, a chilarra or head-band worn across the forehead by natives and a nose-bone, it was fixed upright in the ground close to the Parra. On the last night all the Ilpongwurra were brought in and after having lain for two or three hours in a long line and in perfect silence, with each man's head upon the Parra (this they did every night during the last two weeks), they got up, and a number of small fires were made round the base of the pole. The latter was called the Kau-aua and is the most important and sacred ceremonial object of the tribe. The whole of the night was spent in painting the backs of the Ilpongwurra with various designs characteristic of different totems, but the painting on each man had no relationship of necessity to his own totem, and was always done by the old man to whom he was apmurra.

In the women's camp two large shallow holes were dug out, each about two feet deep, and in these—by the Panunga and Bultharra in one and by the Kumarra and Purula in the other—fires were made.

Just before sunrise the decoration of the Ilpongwurra was complete, and in single file they passed across the river out from the Engwurra ground on to the women's camp, and halted about fifty yards from the fires, behind which the women stood moving their hands up and down as if to invite the men on.

Then each old man led his apmurra men up to the fires, on which they were placed in a kneeling position by the women. The Bultharra and Panunga women put the Kumarra and Purula men on and *vice versâ*. In a short time it was all over, and turning back, the Ilpongwurra, now transformed into Erliāra, or fully initiated natives, returned to the Engwurra ground.

All that remained now to complete the ceremony was for the ban of silence between the men who were apmurra to each other to be done away with. The younger ones had still to remain out in the bush until they brought in an offering of food to their apmurra. When this was done, and it usually took place after an interval of time varying from one to four weeks, the older man performed some sacred ceremony, at the close of which the mouths of all those present were touched with some sacred object which had been used in the ceremony, and in this way the ban of silence was removed.

ART. IV.—*The Wandarral of the Richmond and Clarence River Tribes.*

BY R. H. MATHEWS,

Licensed Surveyor.

[Read 13th May, 1897.]

As no description of the initiation ceremonies of the aboriginal tribes who occupy the country watered by the Richmond and Clarence Rivers, on the north-east coast of New South Wales, has hitherto been attempted, I have prepared the following brief account of the *Wandarral* practised by these people, in which it is hoped the principal parts of the ceremony are detailed with sufficient fulness to enable a comparison to be made between this and other rites of the same character in different parts of the Australian continent. The principal languages spoken by the tribes herein dealt with are the Kahwall and Bunjellung, but there are a few others of less importance.

When it has been determined to call the people together for the purpose of inaugurating the youths of the tribes into the privileges and duties of manhood, messengers are despatched to the different sections of the community, informing them of the time and place of the intended gathering. The head man of the tribe, whose turn it is to muster the people, is generally agreed upon at the last *Wandarral* which was held. That is to say, at the conclusion of the *Wandarral* ceremonies, before all the tribes disperse, their head men assemble in council and arrange amongst themselves which tribe shall take the initiative at the next gathering. It is the duty of this tribe, when the appointed time arrives, to prepare the *Wandarral* ground in some part of their own territory, and get everything ready prior to the arrival of the several contingents whom they may invite to attend the ceremony.

A suitable camping ground, capable of accommodating all the tribes who are expected to be present, is selected near some river, creek, or lagoon of water in a part of the tribe's domain in which there is sufficient game to furnish food for all the people during the continuance of the ceremonies. In the vicinity of this main camp a circular or slightly oval space, known as the *Wandarral*, about thirty yards in diameter, is cleared of all timber and grass, and the soil scraped off the surface in making it level is used to form a mound, or embankment, about nine or twelve inches high around it. The base of the embankment is about eighteen inches wide and tapers upwards to a narrow ridge upon the top. A narrow path, made by scraping the surface of the ground smooth, and throwing the loose earth on either side, leads from this circle to another similarly cleared space, called the *Kangaragal*, which is also bounded by a raised earthen wall, about fifteen or twenty chains distant, in a secluded place out of sight of the *wandarral*. Where the path meets each of the circles an opening about two feet wide is left in the embankment as an entrance to these enclosures. A short distance from the *kangaragal* a fire is kept burning, around which some of the old men camp for the purpose of keeping guard over the sacred ground.

Within the *kangaragal* are two stumps, called the *warrangooringa*, prepared in the following way. Two straight saplings are dug out of the ground by the roots, and their stems or boles cut through about six or seven feet from the base, all the bark being stripped from the stems and roots. The stems are then reversed end for end and are inserted in holes dug into the ground for the purpose to the depth of a foot or more, and the earth rammed in tightly around them to make them stand firm. The roots attached to these stems, being now at the top, spread out laterally to a distance of two or three feet, and some of them even more, and have narrow strips of bark twisted around them to make them ornamental. The stems and roots of these stumps are then stained with human blood, obtained by making small incisions in the arms of several of the men and allowing the blood to drip into bark vessels until a sufficient quantity for the purpose has been collected, after which the wounds in the men's arms are stopped by the application of cobwebs or opossum fur.[1]

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[1] Compare with my description of similar stumps, called *warrengahlee*, used by the Kamilaroi tribes. Journ. Anthrop. Inst. London, xxv., 325; Proc. Roy. Soc. Victoria, ix. (N.S.), 143.

The *warrangooringa* are ten or fifteen feet apart, one being on the right, and one on the left of the spectator as he approaches the ring. There are also two heaps of earth, called *kallagallarranga* within the kangaragal, one of which is only a little way from the entrance, and the other near the opposite or back wall. If the track were continued through the ring it would pass over both these heaps, which are about eighteen inches or two feet high. The *warrangooringa* and the *kallagallarranga* form a quadrilateral within the kangaragal ring.

While the preparation of the *wandarral* ground is in progress, the head man sends out messengers, whom he selects from among his own people, a messenger being sent to each tribe which is required to be present. Each messenger carries a bullroarer, (*dhooanbooka*), and a number of kilts or "tails," and other articles comprising the simple dress of an Australian savage. He wears a painted head-band around his hair, in which are inserted small bunches of long green grass. Two are generally sent together, one of them being charged with the message, and carrying the sacred emblems, whilst the other man merely keeps him company. When a messenger arrives near the camp to which he has been sent, he waits till the men have returned from their day's hunting, and then approaches the single men's quarters, close to which he and his companion sit down. Some of the men then go to the messengers and bring them into the camp. The head men of the tribe are then brought together on the outskirts of the camp, and the messenger tells them where he has come from, at the same time producing the bullroarer and other emblems of authority, which are handed round and inspected by all the old men present. The messenger remains with this tribe until the time arrives to start for the appointed meeting place. All the men, women and children are then mustered up, and the journey commenced towards the *wandarral* ground—dances and songs being indulged in at the various camping places along the route.

On nearing the general encampment, which is usually in the afternoon, a halt is made somewhere near water, and all the people ornament their bodies with stripes and daubs of coloured clays, in accordance with the style customary in their tribe. The messenger then goes on ahead to the *kangaragal*, where he finds some of the old men belonging to the local mob, who are always in attendance there. On the arrival of the messenger, these old men give a shout, on hearing which the men at the main camp know that a new mob is approaching. When the messenger starts on to the *kangaragal* all the strange men and women start direct for the *wandarral*, and when the shouting is heard at the *kangaragal*, the new contingent make their appearance in sight of the main camp. The local mob now accord them the customary reception[1] at the *wandarral* ring, after which the strangers proceed to pitch their quarters on the side of the general camping ground nearest their own country.

Several days, and in some cases weeks, may intervene between the arrival of the various tribes who are summoned to be present, and in order to occupy and amuse the people during this time, corroborees are held every fine night by the light of the camp fires, each tribe present taking their turn to provide the evening's amusement. Every afternoon, when the men come into the camp from their hunting expeditions and have a rest, they go away to the *kangaragal*, where they dance and perform feats of jugglery, and sometimes hold important discussions respecting matters of tribal concern. When these meetings are over they return to the *wandarral*, where the head men call out the names of water-holes, shady trees, and other remarkable places in their respective districts, after which they walk away to their own camps.

When all the tribes who are expected to attend the *wandarral* have arrived at the main camp the head men assemble at the *moodyang*, or private meeting place, and after a consultation among themselves they fix the day on which the novices will be taken away for the purpose of initiation. When the appointed time arrives, the boys are mustered out of the entire camp and taken close to the wandarral ring early in the morning. The brother-in-law, or guardian, of each novice now takes charge of him, and paints him[2] with stripes of pipe-clay on the chest and arms, and puts feathers in his hair, after which he invests him with a belt, four tails or kilts, a head-band, and armlets. The boys are then placed sitting down on the outside of the ring, on the side nearest the camp, their guardians remaining beside them. The mothers and relatives of the novices are also present.

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[1] Journ. Anthrop. Inst., xxv., 321-325.

[2] Generally the mother and sisters of the boy paint him, and the brother-in-law invests him with a man's dress.

After these preliminary performances, the novices are taken away from their mothers in the following manner:—The men and the boys' mothers enter the ring and dance round, after which they come out and go to where the boys are sitting. The latter are then helped to their feet by their guardians, and are taken into the ring and placed standing near one side of the embankment bounding it. Some old men now dance and jump about in the ring, passing from one side to the other for some time, making guttral noises, or singing, as they do so. An old man then advances to one of the novices and places a spear in each of his hands. These spears belong to the boy's guardians, or to some of his friends, and when the boy has held them a short time, the owner steps forward and takes them from the boy and carries them out of the ring, where he lays them on the ground, or leans them against an adjacent tree. Another old man goes through the same routine with another novice, and so on till they have all been disposed of in the same manner. The same old men then approach their respective novices, one after another in the same order as before, and insert one or more boomerangs in the belt of each boy. While these and similar other proceedings are going on, the men and women around the circle are singing and jumping about, going through various pieces of buffoonery.

The guardians now take charge of the novices, bending their heads on their breasts, and, catching them by the arm, lead them away along the track to the *kangaragal*. The men and women who are standing at the *wandarral*, then pick up sticks from the fires, which are burning close by, and throw them into the centre of the ring, and then follow after the novices and their guardians. The mothers and other female relatives go only about fifty yards after the men and then turn back to their own camp. The novices are conducted to the *kangaragal* ring, where they are placed standing near the opening in the embankment, their heads being still bowed upon their breasts. An old head man is sitting on each of the *warrangooringa*,[1] performing magical feats, such as bringing up through his mouth quartz crystals (goorowee) or pieces of string.

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[1] Journ. Anthrop. Inst., xxv., 324

The guardians now catch hold of the boys' heads and straighten them up, telling them at the same time to raise their eyes and take particular notice of the old men. After they have looked at these performances for a while some of the chief men who are standing close by catch hold of the stumps (*warrangooringa*) on which the old men are sitting, and shake them slightly from side to side. While these performances are going on the other men dance round outside the ring, and in a short time the old men descend from the stumps and dance round the heaps of earth, *Kallagallarranga*, before described, followed by a number of the other old men present.

Then one of the guardians leads a novice into the *kangaragal*, and jumps about with him amongst the old men, after which he takes the boy to the other side of the ring, where he remains standing with him. Then another guardian takes another novice and goes through the same performances until all the boys have been dealt with, after which the guardians and novices go out of the ring by stepping over the embankment on the side opposite to that which they entered, where they remain standing as spectators. The old men then pull one of the *warrangooringa* out of the ground and hold it in a horizontal position, and dance round a few times carrying the stump in their hands, after which they lay it down in the middle of the ring. The other stump is now pulled up and a similar performance gone through, after which it is placed on the ground beside the first one. A sufficient quantity of wood, which had previously been collected for the purpose, is then laid down upon these *warrangooringa*, to which a fire is applied, and some of the men remain in the vicinity till they are completely consumed.

The guardians, with their novices accompanied by the rest of the men, then start away and proceed several miles into the bush. The novices have to walk along with their eyes cast down, and are not allowed to look at anything except the ground just in front of them, their guardians being beside them. At some convenient place by the way a stoppage is made, and the boys are put standing in a row with their heads bowed as usual. The men then pass along in front of them, imitating some animal, such as pelicans, kangaroos, or the like, and the novices are permitted to raise their heads and look at them. During the remainder of the day the men engage in hunting, for the purpose of providing food for themselves, as well for the boys and their guardians. On arriving at the camping place a yard is made for the boys, in which they are placed lying down upon leaves which are strewn thickly upon the ground and rugs are thrown over them. This yard is semi-circular in shape, and is built of forks and saplings with bushes laid up against them, the convex end of the partial enclosure being towards the men's camp, which is perhaps fifty yards distant. Across the open end of the yard a few fires are lit to afford warmth to the novices and their guardians when they are occupying it.[1]

When the game which has been caught during the day is cooked by the men at their own quarters, a fair share is taken by the guardians and given to the novices, who are then permitted to sit up, with their backs towards the men's camp, and must eat their food with the blankets or rugs over their heads, so that they cannot see anything around them. None of the men eat any of the game at their own camp until the novices have been supplied with their allowance.

Close to the men's camp, between it and the yard in which the boys are kept, a space is cleared of all grass and loose rubbish, with a fire lit on one side of it. About dusk the novices are brought out and placed sitting in a row on the ground near this cleared patch, facing the fire on the other side of which the men are to perform. Presently the men dance along past the fire imitating the gait and actions of one or more of the following animals :—bandicoots, grasshoppers, wallabies, turkeys, iguanas, native-bears, or any other creature which may have been selected as the subject of the play for the evening. After this the men sing for a while as they sit around the camp fire, and then all hands go to sleep for the night.

The following morning the men start out in search of game, esculent roots, and native bees' nests. The guardians remain at the camp with the boys, and when the men return from their hunting the programme of the evening's performances is arranged, and is carried out by the men in the same manner as on the previous night. Different animals are represented each evening, and the singing is varied as much as their scanty repertoire of songs will admit of, the members of each tribe contributing a fair share. It often happens that a fresh camping place is reached each night, and in that case it would be necessary for the novices and guardians to accompany the rest of the men when they start out in the morning. The novices march along with their heads bowed as usual, and when stoppages are made in the bush, they are put sitting on the ground, and are told not to gaze around them. On arriving at the place which has been selected as the camping ground for the night, a bough yard is made for the boys as before; or if the weather is warm, the yard may be dispensed with. During the evenings at these camping places in the bush human excrement is occasionally given in small quantities to the novices, and they are also compelled to drink some of the urine of the men, collected in a bark vessel for this purpose.[1]

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[1] Journ. Anthrop. Inst., xxiv., 422.

I must now take the reader back to the morning on which the boys were taken away from their mothers at the *wandarral* ring in the manner already described. Shortly after the novices and their guardians have gone out of sight the women pack up all their baggage and start away to another site, which has been fixed upon by the old men, where they erect a new camp, the members of each tribe keeping by themselves on the side facing the district from which they have come—the camp of the local mob forming the initial point. Several old men remain with the women to assist them in removing the camp, and also to watch that everything is conducted in conformity with tribal custom. At this camp the mothers of the novices sing every morning and evening during the time their sons are away in the bush with the head men. When they have been here about a week, another tribe of men and women arrive, and after the usual formalities of reception have been gone through they proceed to erect their quarters on the side of the new camp which is in the direction of their own country. This is the first appearance of this tribe at the ceremonial gathering, and the purpose of their visit is to engage in a sham fight with the other tribes who are initiating the boys, particulars of which will be given presently. They have come from a distant part of the community's territory so that the boys will not know them, and therefore make the encounter appear all the more real.

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[1] See my paper on "The Keeparra Ceremony of Initiation." Journ. Anthrop. Inst., xxvi., No. 99, May, 1897.

The description of the ceremonies in the bush will now be resumed from the point where the above digression was made. When the several pantomimic representations and songs referred to in the preceding pages have been continued for about ten days, one of the men goes from the bush mob to the new camp erected by the women and informs the men there that the course of performances in the bush has been duly carried out. This man does not go openly into the camp but approaches it about dusk, and when he gets within a short distance of the men's quarters, but sufficiently far to be out of sight, he sounds a small bullroarer, called *dhalguñgun*, which he carries for the purpose.[1] When the head men hear this noise they know that some one from the bush camp wishes to communicate with them, and one or more of them go in the direction from which the sound has been heard, and on finding the messenger they enter into conversation with him. He tells them everything which has been done in the bush, and if they are satisfied that the curriculum has been complied with and the novices kept away long enough, they arrange for a meeting place in some well known locality, perhaps a couple of miles from the women's camp, where the mob who have charge of the boys can be found the next day or the day following. The messenger then goes away back to his own mob in the bush and tells them the meeting place which has been decided upon.

On the day which has been thus appointed several old men start away from the women's camp towards the place where they expect to meet the bush mob. On getting about half-way there they form a temporary camping place, where they stop for the present, with the exception of two who go on. When these two men get within hearing distance, they tap two nulla nullas, or other weapons together, and crouch down in the long grass, or among bushes, so as to be out of sight. The bush mob hear the tapping, but pretend they don't know what it is, and say to each other in the presence of the boys, "What noise is that?" The beating of the nulla nullas is again heard, and after this has been repeated several times, the two old men stand up in a place where they are within view of the bush mob and walk towards them. The men and novices now advance towards the two old men, and on getting close to them they leave the boys standing with their guardians, and all the rest of the men run on round the two old fellows, singing and clapping their hands as they jump about. The novices are allowed to see this performance, and at its conclusion the men return to them, and the whole of them go back to where they had just previously come from. The two old men then start away to the place where they left their comrades. The bush mob, including the novices, then paint themselves with coloured clays, and dress in their full regalia. Two more of the old men, before referred to, who are also painted and wearing their toga, are then heard approaching, giving a long-drawn whistle at intervals. When the bush mob hear the whistle, they all lie down in a scrubby place, or in the long grass, to make the novices believe they are hiding. The two old men walk round them a short distance off, but pretend they cannot find them, after which they retire. In a little while two other old men are heard whistling, and the bush mob answer them. Presently they appear in sight, each man carrying in his right hand a boomerang, which he sways from side to side and utters guttural noises. This time they find the men and boys, who are apparently hidden, who get up and jump and swing their arms about. The two old men then turn and run away, and the bush mob follow them, shouting and hitting their weapons together.[1] The two old men keep retreating till they get close to the main camp, when they turn round and face their pursuers. The strange mob of men who arrived at the main camp a few days before, as stated in a previous page, now come to the assistance of the two men, and boomerangs and spears are thrown on both sides, the novices also joining in what is apparently a real fight. When the affray is over the novices are taken away to a camp a short distance beyond the men's quarters, and that night they are shown a number of the sacred quartz crystals belonging to the old head men of the tribes present.

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[1] The *dhalguñgun* is a small bullroarer used by the Clarence and Richmond River blacks. It is suspended on a short string, which is attached to a pliable rod which serves as a handle, and is used in the same way as the *moonibear* amongst the Wiradthuri tribes. —"The Burbung of the Wiradthuri Tribes," Journ. Anthrop. Inst., xxv., 298, pl. xxvi. fig. 39.

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[1] Compare this with my account of the impressive performance of the *beegay* in "The Bora of the Kamilaroi Tribes." Proc. Roy. Soc. Victoria, ix. (N.S.), 167-171.

The next morning the novices are taken some distance into the bush to a place where a circle about fifty feet in diameter has been formed on the ground, similar to the wandarral, but of smaller dimensions. This ring is called *Mahghiñ*, and the trees growing around it are marked with tomahawks in different patterns. The turf is also marked with various wavy and zigzag lines cut into the surface of the ground with sharp pieces of wood used as spades. These grooves in the soil have narrow pieces of bark layed in them to make them all the more conspicuous and ornamental. All the drawings on the trees, and on the surface of the soil are called *moombeery*. The novices are first shown the carvings on the ground, being led by their guardians to each figure with their heads bowed, and are then told to take particular notice of the drawing before them. When they have seen all these, they are next shown all the marked trees, one after another, in the same way. The boys are next placed standing in a row, with their eyes cast upon the ground, near the *mahghiñ*, and the men form into a semicircle in front of them. Two men then step into the open space between the line of men and the novices, and commence swinging bull-roarers (*dhooanbooka*) and the boys are directed to look at them. The head men then step up quite close to the novices, with uplifted spears in their hands, in a menacing attitude, and caution them against revealing anything they have seen in the bush to women or the uninitiated on pain of death.

The men and neophytes are now painted and dressed in their full regalia, and then all hands start for the camp where the mothers of the novices, and the other women and children are located, a messenger having been sent some time before to let them know the boys are returning.[1] The mothers of the latter, and the elder women of the tribe, accompanied by some old men then proceed a few chains from the camp, where they clear a space of all sticks and rubbish which may be lying upon it. Here they light two fires several yards apart, and cut a lot of green bushes which they stack in heaps close by. The women are painted and attired in their tribal dress, standing near the fires, on the side opposite to that from which the contingent is expected to approach. When all is ready, the bush mob appear in sight, marching in single file, a head man walking at each side —one near the front and another near the rear. When they arrive close to the fires, the women throw pieces of bark over the heads of the boys as they approach. Each mother then catches hold of her son, and conducts him to one of the fires, on which some green bushes are now thrown. The mothers, assisted by the guardians, place the novices standing on the boughs, from which a dense column of smoke ascends around them. The men sing, and the old women present wave their arms about while the boys are being smoked. When the two old men who came marching in with the bush contingent consider that the boys have been sufficiently fumigated, they clap their hands together, and the boys then run away with their guardians to a camp, which has been provided for them a short distance off. All the other men are then smoked in a similar way, fresh boughs being laid upon the fires when more smoke is required, and, at the conclusion of the ceremony, the men and women go into the main camp.

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[1] "The Bunan Ceremony of New South Wales." American Anthropologist, ix., 340.

In a few days after the smoke ordeal just described, the strange tribes who have attended the ceremonies make preparations for their departure. Before the assemblage breaks up the head men of each tribe consult together and select the tribe which will have to prepare the next wandarral ground and entertain the people who will assemble there. Each tribe now take charge of their own neophytes, and take them away with them. On their arrival in their own country the boys are still kept under restraint, and are not permitted to mix with the women or children. They must also abstain from eating certain kinds of food, enumerated by the head men, until they are released from these restrictions. When they have completed their term of probation, they are again mustered at a place near the women's camp, and are smoked in the same manner as before. Near this place a net is spread upon the ground and food provided by the mothers is spread upon it.[1] The neophytes are brought up and partake of the food, after which they are taken into a camp near that of the single men. After a time, which may be of some months' duration, the boys are brought nearer and nearer the men's quarters until they are eventually allowed to camp amongst the other young men of the tribe.

It is necessary that each neophyte must participate in one or more subsequent wandarral gatherings before he is fully qualified to take his place as a man of the tribe.[2] The reason of this is evident when it is remembered that, at the first wandarral which a novice attends, he is prevented from seeing the whole of the ceremonial, in consequence of having to keep his eyes cast down during some of the most important parts of it. In many cases a boy is not more than twelve or fourteen years of age when he is first initiated, which is an additional ground for delay in admitting him to the full status of manhood.

The native tribes scattered over the Clarence and Richmond Rivers do not at the present time extract a front incisor tooth of the novice at their initiation ceremonies, and very old blackfellows have told me in answer to my special enquiries on this point that this custom was never practised amongst them.

In this article I have dealt only with the most important portions of the wandarral, and my descriptions of even those are much abridged, in order to keep the paper within reasonable limits. As this is the first account of the wandarral which has ever been published, it is not improbable, in consequence of the numerous particulars to be taken down at each stage of the ceremonies, that some omissions have been made, but it is hoped they will be found unimportant. From a mass of detail now in my note books, the result of many years' acquaintance with these blacks, I am preparing a comprehensive supplementary article on this subject, which will be communicated on a future occasion.

The present paper completes a series of articles communicated by me to different learned societies in Australia, Europe and

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[1] Proc. Roy. Soc. Victoria, ix. (N.S.), 134.

[2] Journ. Anthrop. Inst., xxvi., 284, *note* 1.

America, in which I have described the initiation ceremonies of various tribes covering about three-quarters of the total area of the colony of New South Wales. This immense tract of country is comprised approximately within the following geographical limits. Commencing at Point Danger it follows along the boundary between New South Wales and Queensland as far as Warrego River, thence it is bounded by an indirect line to the junction of the Murrumbidgee and Murray Rivers, thence up the last-named river and onwards along the Victorian boundary to Cape Howe, and thence by the Pacific Ocean to Point Danger. My researches have also been carried a considerable distance into Queensland, as well as into the Victorian frontier; particulars of the areas within which I have worked will be stated at another time.

Art. V.—*Geology of the Lower Moorabool.*

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and

G. B. Pritchard,

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(Plates I. and II.)

[Read 10th June, 1897.]

The valley of the Moorabool River from its confluence with the Barwon, at Fyansford, to a short distance above Maude, displays a series of sections extending over some twenty miles in length which clearly illustrate the diversified character and the relations of our marine tertiary beds and the deposits associated with them. We have previously described the series as shown at the southern end of the valley, and pointed out that the Miocene beds of the old survey really underlay their Oligocene (1). At a subsequent date we dealt with the tertiaries in the neighbourhood of Maude (2), and showed that the same sequence held, while the close relationship between the marine beds underlying the Older Volcanic rock and those of Spring Creek enabled us to indicate the sequence of the tertiaries generally. Since the publication of these papers we have examined the valley for some miles to the north of Maude, and also the undescribed and only partly mapped portion between Russell's Bridge (The Clyde) and the railway viaduct near the Moorabool Station. Our inspection of the beds shows that the general south-westerly dip, which we previously indicated as existing in the southern part of the valley, holds as far to the northward as Maude, near to which place the marine conditions give place to freshwater ones.

Beginning at the northern end of the area under consideration, we find that about half a mile above the confluence of Woolshed Gully, or about a mile and a half below the junction of

Coole Barghurk Creek, there is a thick mass of volcanic rock overlying the Ordovician. Its thickness we estimated at about 150 feet. The lower part of the igneous rock, as seen in several sections, is very much decomposed, while that near the surface is columnar and sound. It would appear from this that there is some difference in the age of the upper and lower parts.

On consideration we are inclined to think that the Newer Volcanic rock here rests on the Older Volcanic without the presence of any intervening beds, and it is not till we have gone some three miles to the southward, in the neighbourhood of the Maude Bridge, that we are able, owing to the occurrence of an intercalated marine limestone, to separate the two with certainty.

Under the volcanic rock occurs a deposit of sand and gravel, which can be traced down stream till it is clearly seen to pass in its upper part into the Lower Maude marine beds, the representatives, as we have previously stated, of the Lower Spring Creek series. To the northward these gravels, which are in places represented by quartzites, have been shown by Selwyn and the officers of his staff to underlie auriferous gravels, and where examined by them, to be not gold-bearing (5). From the data thus obtained, as well as from observations on some of the older gravels elsewhere, which were also non-auriferous, Selywn arrived at the conclusion that gold was not to be found in Miocene gravels. In the same report (5, p. 24) he says, "No beds whatever containing marine fauna are known in Victoria overlying alluvial or drift gold deposits." Since then, however, such beds have been found near Stawell under marine deposits of apparently Eocene age. Selywn's explanation of what he held to be the non-auriferous character of the Miocene gravels is that the age of the auriferous quartz reefs was Post-Miocene, the non-auriferous ones being of greater age. Now that we know of the existence of detrital auriferous deposits of greater age, another explanation of the absence of gold from the gravels north of Maude must be sought, and the true one appears obvious. The gold in our Ordovician is practically confined to beds of certain ages, and we thus find the north and south lines of auriferous country separated by barren belts. One of us has shown that such a barren belt is indicated at Castlemaine by the presence of graptolites belonging to what he has called the *Loganograptus* zone (6, p. 76). Graptolites of a slightly higher horizon occur in Sutherland's Creek, and a few that may be of the same age at the localities shown on Quarter-sheet 19, S.W., in the Moorabool Valley. The reason, then, for the absence of gold in the gravels appears to be that they have been derived from a barren belt of Ordovician, and not that the character of the quartz veins depends on the age of their formation.

At the locality marked W.T.M.8. on the Quarter-sheet the summit of the Ordovician is about eighty feet above the level of the river, which flows through a rugged gorge. Half a mile below this the gravels pass up into marine beds.

These consist in the main of polyzoal limestones, and are strongly current bedded, containing quartz grains the size of a pea, as well as numerous flakes of slate. In places the limestone is crowded with vast quantities of the peculiar little echinoderm, *Fibularia*. These beds, which are a part of the "Lower Maude Series," are probably about the level of Lethbridge Station, which is 547 feet above sea level, and are the most northerly exposure of the marine beds. From here the surface of the Ordovician drops rapidly as we go south, and in about two miles it has disappeared beneath the level of the bottom of the valley. The Lower Maude series of marine beds, which have now almost entirely displaced the gravels, disappear in the same way a little further down stream, as shown on the Quarter-sheet. The section just above this is described in a previous paper (2); but it may be recalled to mind that the surface of the Older Volcanic rock is about 190 feet above the level of the stream, which has a fairly rapid fall. The limestone and sands overlying the Older Volcanic rock may be traced continuously for four miles to the southward, when we reach the quarry opposite the Clyde School (2, p. 183). Here the surface of the volcanic rock has dropped to about 40 feet above the level of the stream, in spite of the rapid fall of the latter. The Upper Maude limestone is now overlain by fossiliferous clays, into which it passes upwards, the fossils from the clays showing, as we have previously pointed out, the closest agreement with those of the clays associated with the Batesford limestone. About a mile and a half further down the stream we recently noted the most southerly outcrop of the Eocene basalt, namely in Section IV., Allotment B, Parish of Darriwill. The following section is displayed on the left bank. From the water's edge up to 40 feet is a very vesicular and rubbly decomposed basalt. On this rests the Eocene rock. Fragments of polyzoal rock were found, as well as brown sandy limestone. Then occurs a stretch of level ground which runs back from the river to an escarpment of Newer Volcanic rock, which flanks the Maude tableland. There is no clear exposure of the Eocene rock in the section, but it is visible a quarter of a mile below under the Newer Volcanic rock, dropping rapidly to the southwards, as seen in the long cliff section. There is, as mentioned, no actual exposure of the Older Volcanic rock south of this, and judging by the soil and surface contour we think it comes to the river level near the house in Section IV., Allotment E (Calleray's). The slopes about here are composed of the marine series with the usual capping of Newer Volcanic rock. About half a mile south of Calleray's there is an exposure of Eocene in the river bed at the foot of a steep cliff. On the opposite (right) bank of the stream a long escarpment runs east and west, and the almost horizontal lines of stratification, as shown by the earthy limestone bands, are a marked feature in the landscape. From a road-cutting along the foot of this hill, about a couple of hundred yards above Moodie's homestead, we gathered a few fossils.

Brachiopoda.
  Terebratula vitreoides, T. Woods.
Lamellibranchiata.
  Ostrea sp.
  Pecten murrayanus, Tate.
  Lima linguliformis, Tate.
  Leda vagans, Tate.
  Nucula tenisoni, Pritchard.
  Limopsis belcheri, Adams and Reeve.
  Pectunculus laticostatus, Quoy and Gaimard.
  Plagiarca cainozoica, Tate.
  Corbula pyxidata, Tate.
Gastropoda.
  Tenagodes occlusus, T. Woods.
  Emarginula sp.

Scaphopoda.

Dentalium aratum, Tate.
Entalis mantelli, Zittel.
,, subfissura, Tate.

Half a mile below, a similar road-cutting near Baker's gave us another opportunity of seeing the nature of the beds clearly. The valley hereabouts is of less depth than almost anywhere else, being only about eighty feet deep. The marine beds are about sixty feet thick, and pass up from grey sandy marls into more sandy beds with bands of hard, ringing, concretionary limestone, and towards the top become more ferruginous. The face of the section is sparsely strewn with small quartz pebbles, but we could not find any bed from which they might be derived. The remaining twenty feet of the hill consists of the usual volcanic capping, the rock being a rather coarse dolerite, judging by hand specimens. Fossils were only obtained from the lower part of the section, are not very common, and are of Eocene age.

Baker's Road-cutting.

Foraminifera.

Zoantharia.

Flabellum victoriæ, Duncan.
Conosmilia anomala ?, Duncan.

Echinodermata (Cidaroid spines).

Polyzoa.

Lamellibranchiata.

Dimya dissimilis, Tate.
Pecten zitteli, Hutton.
Meleagrina crassicardia ?, Tate.
Barbatia celleporacea, Tate.
Leda vagans, Tate.
Trigonia tubulifera, Tate.
Crassatella communis, Tate.
Cardita polynema, Tate.
Cytherea eburnea, Tate.
Myochama trapezia, Pritchard.

Gastropoda.

Ranella prattii, T. Woods.
Genotia angustifrons, Tate.

Pleurotoma sp.
Thylacodes conohelix, T. Woods.

Scaphopoda.

Dentalium aratum, Tate.
Entalis subfissura, Tate.
,, mantelli, Zittel.

Pisces (otoliths).

About a mile to the south of this, on the road which runs south from Baker's Bridge, is a small cutting in yellow calcareous sandstone, with very hard bands of limestone. This proved a difficult bed to work for fossils, as they were very scarce, and when found consisted only of hollow casts. The nature of the rock, however, was such that the imprint of the ornament was beautifully sharp, and there was very little difficulty in recognising the greater number of the specimens as soon as they were exposed by the hammer.

GHERINGHAP.

Foraminifera.

Crustacea (crab chela).

Polyzoa.

Brachiopoda.

Terebratulina scoulari ?, Tate.

Lamellibranchiata.

Lima bassii, T. Woods.
Chione cainozoica, T. Woods.
Cardita delicatula, Tate.
Chama lamellifera, T. Woods.

Gastropoda.

Mitra ligata ?, Tate.
Scalaria sp.
Turritella tristira, Tate.
,, acricula, var., Tate.
,, platyspira, T. Woods.
Rissoa sp.

Scaphopoda.

Dentalium aratum, Tate.
Entalis mantelli, Zittel.

As a few hundred yards below this cutting there is a long outcrop of limestone marked on the Quarter-sheet, 24 N.E., the boundary of which we were now approaching, it was very necessary that clear evidence as to its age should be obtained. This strip of limestone is shown on the map as immediately underlying the Pliocene beds, which are mapped as very thick from here to the viaduct, and though the outcrop is clearly enough shown on the map, yet there was but one small exposure in an old disused quarry, the extent of the bed being indicated by the numerous scattered fragments of limestone at the foot of the escarpment. Owing to the unfortunate system of representing all limestones by a blue colour on the quarter-sheets, no hint of the age of the bed is given, and it is merely shown to underlie the Pliocene deposit. In the outcrop at the quarry we could find no identifiable fossils, a few fragmentary polyzoa and foraminifera being all that we saw. There can, however, be no doubt whatever that the outcrop is part of the same bed as is exposed in the road-cutting just mentioned, and it must consequently be referred to Eocene age.

To the north of this the river skirts the southern boundary of a small area of granite, as shown on the Quarter-sheet. South of the confluence of Sutherland's Creek, which skirts the granite area on its eastern border, a small exposure of limestone is mapped, and is represented as intercalated in Pliocene beds. At the locality indicated we found numerous boulders of white, hard, magnesian limestone strewn about near the foot of the slope, but it appeared not to be fossiliferous, and its original position is not clear. We found none *in situ*, and it may be merely a decomposition product from the overlying volcanic rock, and perhaps owes its present position to its having rolled down the face of the escarpment. To the south-west of this point, owing to the removal of the volcanic rock by denudation over about a square mile of country, a series of beds are brought to view which are mapped as "Older Pliocene." In their upper part they pass under the edges of the basalt plateau, and a couple of railway cuttings through small basaltic outliers show the relationship of the two sets of beds very clearly. The basalt cap, as shown in the cuttings, is very thin, nowhere exceeding twenty feet in thickness, and thins out to nothing at the two ends of each of the cuttings. Under the basalt comes a deposit of ferruginous sandstone bands, sands and gravels, at times passing irregularly into white sands, with here and there a few nodules of hard quartzite just below the volcanic rock. The texture varies from exceedingly fine, well-rounded sands to light gravel, and a prolonged search for fossils in these cuttings showed, as is so often the case in rocks of this character, that organic remains are few and far between; in fact, all we found was the imprint of a single leaf, showing probably the fresh-water nature of the deposit. On the northern slopes towards the river, and at a lower level than these beds, the Quarter-sheet notes "Ironstone full of fossils." These fossiliferous beds are exposed in an old road-cutting leading down to the river, but fossils are more plentiful in the loose blocks which thickly strew the slopes below. The deposit is of especial interest, as the beds prove to be of Miocene age.

MOORABOOL VIADUCT.

Miocene Fossils.

Lamellibranchiata.

- Placunanomia ione, Gray.
- Modiola sp.
- Leda woodsi, Tate.
- Leda sp.
- Nucula tenisoni, Pritchard.
- Trigonia acuticostata, McCoy.
- Chione subroborata, Tate.
- Cytherea submultistriata, Tate.
- Mactra hamiltonensis ?, Tate.
- Myadora corrugata, Tate.
- ,, brevis, Sowerby.
- Corbula ephamilla, Tate.
- Barnea tiara, Tate.

Gastropoda.

- Phos tuberculatus, Tate.
- Nassa sublirella, Tate.
- ,, crassigranosa, Tate.
- Cancellaria wannonensis, Tate.

Pelicaria coronata, Tate.
Natica varians, Tate.
Turritella sp.
Lampania sp.
Bankivia sp.

The whole of the above twenty-two species are obtained in Miocene deposits elsewhere, whereas only five are recorded as ranging into the Eocene.

Of the above twenty-two species seventeen have been specifically named, including one doubtful identification; the remainder are as yet undescribed species.

The seventeen described species occur elsewhere as follows :—

Muddy Creek Miocene - -	17 (1 doubtful).
Jemmy's Point Miocene - -	17 ,,
Beaumaris Miocene - - -	13

The Quarter-sheet bears the same colour from the top of the hill down to the river flat, the whole series being referred to Older Pliocene. Towards the foot of the hill, however, the character of the beds changes, and, though we found no fossils, it is probable that the lower part of the beds is Eocene, as fossiliferous beds of this age occur less than half a mile lower down the stream and are in their upper part of similar lithological character.

The presence of marine Miocene beds here, where they are so clearly overlain by volcanic rock, is of importance when viewed in connection with a deposit recently described by Messrs. J. Dennant and J. F. Mulder at Shelford, about eighteen miles to the westward of the present locality (3). Finding the marine Miocene beds resting on basalt, and basalt also occurring further from the river, and at a higher level, these authors have assumed that the two basaltic outcrops belong to the same period and practically to the same flow. Arguing from these premises they state their view to be that the basalt forming this portion of the Western Plains is not younger than Miocene, and they ascribe the presence of the marine Miocene beds in that locality to a submergence after the gorge had been partly cut out by the stream. An examination of the section which they give, however, shows that a different interpretation may be placed on their observations, namely, that there are really two basalts of distinct ages present and separated by marine beds. The fact that, at the Moorabool locality, the basalt overlies the Miocene beds is certainly strong presumptive evidence that the relative position to which Messrs. Etheridge and Murray referred the newest of the basalts of the Shelford district is the correct one, namely, that it is subsequent to the beds which the Survey termed Older Pliocene, and which are now generally called Miocene. Messrs. Dennant and Mulder state that, in the section in which they found the Miocene deposit, the base of the volcanic rock is hidden by the recent river alluvium. If then, as appears probable, there be two basalts at Shelford, the age of the lower one is still undetermined. It must be pre-Miocene, and from its close proximity to the Eocene basalt of Maude, it will quite possibly be found to be a part of the same flow.

The railway cutting on the left bank of the stream shows, under a thin basalt capping, beds of the same character as those described above on the right bank, and yielded no fossils. Eastwards from the Moorabool Railway Station the railway runs in the valley of Cowie's Creek, and several cuttings show the beds beneath the basalt capping, and they are also displayed in natural sections in the valley. Daintree and Wilkinson, who mapped the Quarter-sheet, 24 N.E., indicate two sets of beds as occurring, namely, "Older Pliocene" and "Miocene," or, as we consider them, Miocene and Eocene. Judged by the light of the section above described to the west of the viaduct, it is possible that this is correct, as the levels are about the same. The beds merely differ in the fact that these to the eastward are not highly ferruginous. They are sandy, sometimes calcareous, and in places in immediate contact with the overlying basalt are changed to quartzites. The dip is slight and is at first north-westerly, whereas further east, where the age is shown to be Eocene by the fossils, the dip is reversed, being to the south-east. These are only apparent dips, as shown in the railway cutting. About four miles to the northward a small patch of Miocene (? Eocene) is mapped (this outcrop is uncoloured in some copies of the Quarter-sheet, but is coloured Miocene in others), and an anticline with a north-east strike is shown. The axis of the anticline would run, if produced in a straight line, near to this locality.

The evidence, then, as to whether we have here an anticline in Eocene strata merely, or an unconformable junction between easterly dipping Eocene and westerly dipping Miocene is fairly evenly balanced, and we leave the question open. At the locality marked as fossiliferous on the Quarter-sheet (Section 104) we found fossils in the railway cutting and also close to the creek bed which showed the Eocene age of the deposit. The upper beds yield very few forms, but those at the lower level are fairly rich, though the fossils are very much decomposed.

RAILWAY-CUTTING.

Foraminifera.
Cidaroid spines.
Crustacea (crab carapace).
Polyzoa.
Brachiopoda.
    Waldheimia insolita ?, Tate.
    Terebratulina scoulari, Tate.
Lamellibranchiata.
    Ostrea sp.
    Pecten sp.
    Limatula jeffreysiana ?, Tate.
    Spondylus pseudoradula, McCoy.
    Dimya dissimilis, Tate.

COWIE'S CREEK.

Brachiopoda.
    Terebratulina scoulari, Tate.
Lamellibranchiata.
    Pecten zitteli, Hutton.
    Leda vagans, Tate.
      ,, apiculata, Tate.
      ,, huttoni, T. Woods.
    Limopsis belcheri, Adams and Reeve.
    Plagiarca cainozoica, Tate.
    Cardita polynema, Tate.
      ,, delicatula, Tate.
    Diplodonta subquadrata, Tate.
    Cytherea eburnea, Tate.

Pholadomya australica, Tate.
Cuspidaria subrostrata, Tate.

Gastropoda.

Cypræa leptorhyncha, McCoy.
Cassidaria gradata, Tate.
Natica hamiltonensis, T. Woods.
Turritella sp.
Tenagodes sp.
Cerithium apheles, T. Woods.
Tinostoma parvula, T. Woods.
Emarginula sp.
Cylichna sp.

Scaphopoda.

Dentalium aratum, Tate.
Entalis mantelli, Zittel.
,, subfissura, Tate.

With the exeception of the section noticed by us in a previous paper (1), there does not appear to be any fossiliferous exposure of Eocene rocks between the viaduct and the limestones below Batesford. In the same paper we described the nature of the beds displayed in the river sections between Hope's Mill-dam and Fyansford, and subsequently again referred to the section displayed at M'Cann's Filter Quarries (2, p. 193), and gave a list of fossils from the clays of the section (4, p. 161).

The question of the difference of level of the lava on the two sides of the Moorabool, between Batesford and Fyansford, we alluded to in a previous paper (1). It seems probable that the lava to the west, occupying the lower level, is younger than that capping Orphanage Hill, the latter being a southerly extension of that capping the Miocene beds near the viaduct. This suggestion would, of course, imply great denudation over a considerable area after the effusion of the Orphanage Hill lava. From a careful examination of the district we do not think that it can be due to faulting, although faulted marine tertiaries occur at no great distance, namely at Waurn Ponds and at Curlewis. At the former place the limestone at M'Cann's old quarry is cut off to the southward by a vertical fault, the amount and direction of the displacement not being known, and the quarry is abandoned, while the slight series of step faults at Curlewis we have described elsewhere.

SUMMARY.

The long series of sections displayed in the valley of the Moorabool shows very clearly the sequence of our Eocene rocks. The general dip is in the direction of the stream, and at a more rapid rate than the fall of the valley, so that the beds disappear in regular order as we go southwards. The Upper Marine Series near Maude, classed as Upper Miocene by the Survey, is seen to pass beneath clays which are the near representatives of, if not absolutely identical with, those of Orphanage Hill, Fyansford, which have been referred by the Survey to the Oligocene. and by us to the Eocene. These beds extend in the valley from near the Maude bridge, with perhaps a short break near the junction of Sutherland's Creek, to the Barwon. Near the viaduct they are overlain by marine and freshwater Miocene beds, which are in turn capped by the lava flow of the plains.

Beneath the Upper Maude beds is seen the Older Volcanic, extending from near the confluence of the Coole Barghurk Creek for about ten miles down stream, when it disappears beneath river level. Under the Older Volcanic sheet, and between it and the Ordovician, is a series of beds which to the northward is of freshwater origin and contains plant remains—the "Miocene gravels" of Selwyn. At about two miles above Maude they contain a marine fauna in their upper portion, and they dip below river level some three miles below this point. This fauna we have previously correlated with that of Spring Creek.

A tongue of the Anakie granite, as shown by numerous outcrops, extends down Sutherland's Creek, through the Dog Rocks, and reaches as far to the southward as the north-western border of the Barrabool Hills. At the Dog Rocks and at the Barrabool Hills gabbro is associated with it. The relations of the two rocks are being, we understand, worked out by Mr. E. G. Hogg. Here, as elsewhere in Victoria, the granite is probably Post-Silurian, and intrudes the graptolite-bearing Ordovician, which is extensively exposed in the northern parts of the area treated of.

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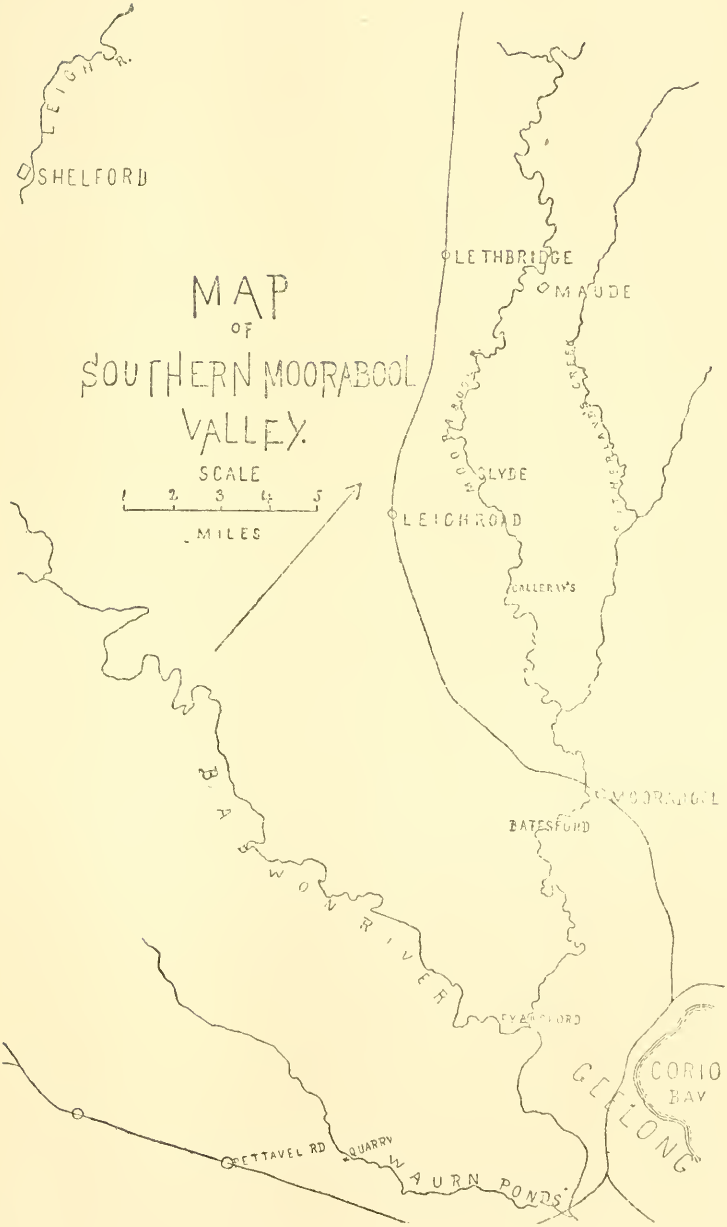
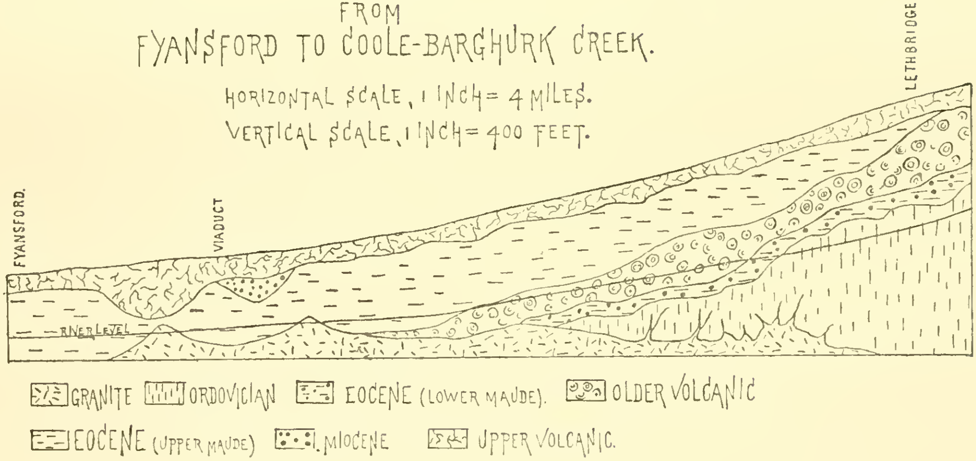

LEIGH R.
SHELFORD
MAP OF SOUTHERN MOORABOOL VALLEY
SCALE
1 2 3 4 5
MILES
LETHBRIDGE
MAUDE
MOORABOOL
SUTHERLAND'S CREEK
CLYDE
LEIGH ROAD
CALLERAY'S
MOORABOOL
BATESFORD
BARWON RIVER
FYANSFORD
GEELONG
CORIO BAY
PETTAVEL RD
QUARRY
WAURN PONDS

SECTION
FROM
FYANSFORD TO COOLE-BARGHURK CREEK.

HORIZONTAL SCALE, 1 INCH = 4 MILES.
VERTICAL SCALE, 1 INCH = 400 FEET.



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ART. VI.—*Note on a Tooth of Palorchestes from Beaumaris.*

By T. S. HALL, M.A., and G. B. PRITCHARD.

[Read 10th June, 1897.]

Some years ago one of us found on the beach at Beaumaris, just below the present hotel, a mammalian tooth which is of some interest. The geology of the locality has been briefly dealt with by us in a previous paper (1., p. 190); but, not feeling sure of the nature of the tooth, we made no reference to it till it had been examined by some one well qualified to give an opinion upon it. As Mr. C. W. De Vis has long been working at our fossil mammals, we sent the tooth to him, and we wish to express our thanks to him for the information which he, as usual, so promptly supplied.

Unfortunately the tooth was not found *in situ*, but loose among the pebbles on the beach floor, so that the precise horizon cannot be definitely asserted. The locality has long been a favourite collecting ground for shark's teeth, which used to occur in great numbers on the beach, but the steady search of numerous visitors has now rendered them scarce, so that instead of getting forty or fifty in an afternoon, a couple may be all that reward a careful search. These teeth seem to have been derived from a thin band about low water level which has yielded many other fish teeth and the remains of *Physetodon baileyana*, M'Coy. The presence of fossil wood in the deposit shows that land was at no great distance at the time when the marine beds were laid down. Below the beach floor the beds are undoubtedly of Eocene age, and those of the cliffs were referred to the same age by Messrs. Tate and Dennant. From this view we dissented, and gave our reasons in the paper above referred to (1). As far as we have been able to discover, no beds of later age occur in the neighbourhood from which the fossil could have come, and its mode of preservation and general appearance is very similar to the tertiary bones found at the same place. Still till further evidence, in the shape of similar material *in situ*, be obtained the question as to the age of this tooth must remain unsettled, the balance of evidence being in favour of Miocene. The earliest fossil mammal known in Australia was found many years ago in the Eocene Turritella beds of Table Cape, Tasmania. This was referred to by Mr. S. H. Wintle as a "fossil wallaby" (2). Mr. R. M. Johnston has since then spoken of the specimen as *Halmaturus* (3).

Whatever the exact nature of the Tasmanian fossil may be, it is undoubtedly a terrestrial mammal, and as its being *in situ* in the Eocene beds appears certain (4), there is no *a priori* argument against the tooth we are dealing with being as old as Miocene.

As regards the zoological position of the specimen we cannot do better than quote Mr. De Vis' letter.

"The tooth which you are good enough to send me is unquestionably one of the upper premolars of a large diprotodont marsupial. Had it occurred in an ordinary turbary or lacrustine deposit I should have had little hesitation in saying that it was the right permanent upper premolar of the gigantic Kangaroid, *Palorchestes azael*, Ow., the largest of the transition forms between the true kangaroos and the Nototheriidæ. But if it were really derived from a deposit of Meiocene age it would be well nigh impossible for it to belong to *P. azael*, an associate of living mollusks, and it must therefore be provisionally referred to an earlier species of the genus. In either case the tooth is of much interest, whether it leads us eventually to attach to the Nototherian fauna a much higher antiquity than we have hitherto imagined, or whether it merely exemplifies the premolar of *P. azael* in a much younger and more perfect state than the only other tooth hitherto known, which is greatly degraded by wear.

I hope you will be able to fix the real age of the tooth by finding bones of the like origin *in situ*."

Our object in writing this note is to bring before any geologists working in the neighbourhood the desirability of keeping a look out for similar specimens in the Miocene beds, though the marine conditions then prevailing, coupled with the fact that the band yielding the shark's teeth is only reached by digging below high water level, render the chances of finding them somewhat remote.

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Art. VII.—*The Geology of Coimaidai.*

Part I.

The Coimaidai Limestones and Associated Deposits.

By Graham Officer, B.Sc., and Evelyn G. Hogg, M.A.

[Read 10th June, 1897.]

The geological interest of the district of Coimaidai arises from the occurrence there of (1) magnesian limestones containing mammalian bones, and of (2) glacial deposits. Some of our conclusions concerning the latter beds have been already given in a paper read at the last meeting of the A.A.A.S. at Brisbane. In the present paper only the limestones and other formations associated with them will be dealt with.

The area under description is situated in the parishes of Merrimu and Coimaidai, County of Bourke, and lies a few miles north of the town of Bacchus Marsh; it is included between the Lerderderg River on the west and south and the Djerriwarrah Creek on the east, while northwards it extends some miles towards Mount Bullengarook. In addition to the two streams mentioned, several creeks, flowing in a southerly direction, traverse the area, exposing many good sections along their courses. The principal creeks are Goodman's Creek, Boggy Creek, and Pyrete Creek. It is in the valley of the latter creek, in the vicinity of the township of Coimaidai, that the limestones are best exposed. The area of the district is about thirty-six square miles.

The formations developed in the district are, in ascending order—

(1) Lower Silurian.
(2) Permo-carboniferous Glacial beds.
(3) Coimaidai limestones, gravels, conglomerates, etc.
(4) Newer Basalt.
(5) Post-Tertiary and recent beds.

The deposits described in the present paper are those contained in the three last groups of the above list.

With regard to the previous geological work in this district we are informed by Mr. Stirling, Government Geologist, that surveys of this part of the country were executed many years ago by the Government officers, but the results were never published, and all trace of them appears to have been lost. The only published account of the geology of Coimaidai is a short report by Mr. Ferguson, Assistant Government Geologist, contained in the Mining Department Progress Report, No. VIII., 1894. Mr. Ferguson gives a sketch map and sections, reference to which will be made further on.

As already mentioned, the limestones are best studied in the neighbourhood of the township of Coimaidai. On the eastern side of the Pyrete Valley, opposite Mr. Bennett's hotel, are two large quarries, Alkemade's and Bennett's, in which splendid sections are exhibited; a third and smaller quarry (Burnip's) occurs on the west side of the valley. The material quarried is a magnesian limestone, used for the manufacture of lime and hydraulic cement. It is in this formation that the mammalian bones have been discovered which give to these beds their peculiar scientific interest. The bones already found included fairly well preserved jaw-bones of the kangaroo and wombat, fragments of jaw-bones of a macropoid type, and portions of long bones.

The writers of this paper are in communication with Mr. C. de Vis, M.A., of Brisbane, with a view of obtaining from him a detailed description of the bones in their possession, and also of those collected by Mr. Ferguson, which have been kindly placed at their disposal for this purpose by Mr. Stirling, Government Geologist. It may here be mentioned that bones and fragments have been obtained *in situ* by each of the writers under circumstances which entirely preclude the supposition that the bones found by them may have made their way in comparatively recent times to the positions in which they were discovered by means of earth-cracks or fissures. The entombment of the bones certainly took place contemporaneously with the deposition of the enclosing sediments.

In view of the importance attaching to the discovery of mammalian bones in Victoria, somewhat detailed accounts will be given of the deposits in which they occur. The floor on which the limestone quarries rest is not visible, but from an examination of the surrounding strata the bed-rock is clearly either the glacial boulder clay or Lower Silurian: almost certainly the latter in the case of Burnip's quarry.

The series exposed in the quarry sections consists mainly of magnesian limestone, with intercalated beds of calcareous sand, grit and gravel. They are well stratified, especially towards the upper part of the sections. The several beds exposed have undergone a considerable amount of disturbance and contortion; they have a general dip in towards the bottom of the valley, the average dip being about 20°, although angles of 30° have been noted.

There can be little doubt that the cause of the disturbance and contortion of the beds is to be found in the character of the beds themselves. By the solvent action of percolating waters caverns and hollows have been formed in the limestone; at a later stage subsidence has taken place in, as might have been expected, a more or less irregular manner. In places where a band of clay adjoins a limestone bed it may be noticed that the clay has been forced into cavities dissolved out of the limestone; the effect of this intrusion of the clay is to give an appearance of unconformity, which is, however, at once dispelled by a more complete study of the sections. In connection with this matter it may be noticed that the lowest points to which the quarries have been worked are still at a moderate height above the level of the creek draining the area.

Section at Alkemade's Quarry.

All the beds represented cannot be seen exposed in one face, but by following out the strikes and dips the following section has been constructed, showing the relative positions of the various beds and their approximate thickness in each case.

In descending order we have :—

(1) Gravel and ferruginous conglomerate, 8 feet.

(2) Very fine blue clay, interspersed with finely-laminated limestone shales of varying texture and hardness, and containing lenticular masses of hard, compact

limestone, 10 feet. The clay bands vary much in thickness and show considerable disturbance.

(3) Yellowish limestone, soft as a rule, but containing lenticular bands of hard limestone, 6 feet.

(4) Thin bed of ash, 6 inches. This stratum varies in thickness from two inches to one foot. In marked contrast to the individual beds of the series, it has a wide distribution; it has been picked up on both sides of the valley, and constitutes a valuable bench mark.

(5) Yellowish white limestone of varying texture and hardness; it is honeycombed in places, 6 feet.

(6) Gravel and calcareous sand, 12—15 inches. The gravel is mainly quartz, but fragments of neighbouring Silurian rocks are frequent. The pebbles composing it are somewhat angular as a rule.

(7) Calcareous sand, 3 feet. It is somewhat soft, but merges into harder calcareous bands in places. It is from this bed that the mammalian bones have been for the most part obtained.

(8) Grit, sand and gravel, more or less calcareous, 1 foot 8 inches.

(9) Soft, earthy and gritty limestone, passing into a harder, somewhat ferruginous, material containing lenticular masses of hard, compact stone, 6 feet.

(10) Hard, compact limestone, very fine-grained in places, in others gritty, with quartz grains. The colour varies from a fawn colour to white or bluish-white, the rock of the latter tint being exceedingly fine-grained. About two feet of this bed is exposed; it is the lowest to be seen in the quarry. We were informed by the Messrs. Alkemade that they sank a shaft for about thirty feet through this stratum without reaching the bed-rock.

The thickness of the section we have constructed may be taken to be about forty-four feet, and if the thickness of the last-mentioned bed be taken at twenty-six feet, a total thickness of seventy feet in round numbers for the whole series is obtained. The thickness of rock above the bone bed is about thirty-three feet six inches. Magnesite filling in fissures occurring in the limestone is found in large quantities.

The details of the section of Bennett's and Burnip's quarries are omitted, as no bones have been obtained by us here. Their general character is very similar to that of Alkemade's quarry; the ash-bed previously referred to is shown in each quarry.

The only other fossil remains yet found in these quarries are vegetable; though abundant, they are extremely fragmentary. They appear to be mostly fragments of grasses and perhaps characeous plants. Some of the limestones are traversed by innumerable minute branching perforations, often coated with a thin pellicle of iron oxide, which may possibly be casts of rootlets of plant life. Other branching forms are found, but they are very indefinite in character. One fragment of a fern has been obtained. A microscopic examination of thin sections of the limestone reveals minute spherical bodies, which may possibly represent the spore cases of characeous plants.

Leaving the quarries, in which the main development of the limestone occurs, we proceed to trace their stratigraphical relation to the other formations of the district. Along the eastern side of the Pyrete Valley and towards its head the limestone can be seen outcropping in several places, the apparent dip in each case being into the valley. At one place, a quarter of a mile from Bennett's quarry, where a small cut has exposed the limestone, the ash band before referred to is to be again seen.

A short distance above this latter point, as one ascends the hill in a south-easterly direction, an extensive outcrop of an intensely hard quartzite is met with, and towards its base this formation appears to gradually pass into a softer rock which contains both lime and magnesia. In this rock small segregated veins and patches of a highly silicious nature are frequent. The quartzite varies considerably in texture, being very fine grained and almost cherty in places, while in others it is much coarser and merges into a quartzitic grit and conglomerate.

Passing on up the hill beds of more or less cemented sand, gravel and ferruginous conglomerate are encountered, the uppermost being chiefly of the latter material. A remarkable feature is the great variability in texture of these beds, some being intensely hard, while others are soft and incoherent. The ferruginous cementing material appears to be often replaced by silica, and all the harder cemented rocks seem to have the form of lenticular sheets, varying much in extent. On the other side of this hill, remote from the quarries and close to the Melton Road, an outcrop of limestone is seen in a small gully; it is overlain by ferruginous rocks, and has an apparent dip in a north-easterly direction. Along the road from Coimaidai to the Bullengarook Road outcrops of sandstone, gravel and conglomerate occur; the topmost beds, which lie directly under the basalt, are about 240 feet above the base of the quarries. It is thus seen that, in the vicinity of Coimaidai, the limestone is overlain by series of sands, gravels, quartzites and conglomerates, the bed superposed on the limestone being different in different places. That the limestone of the quarries is older than the associated beds, and does not occupy a valley of erosion in them, is clear to the writers from the following considerations:—

(1) Its apparent position with regard to the overlying beds.

(2) The absence of either rounded or unrounded fragments of grit, quartzite, or conglomerate in the limestone, or gravels intercalated with the limestones in the quarries.

It is indeed fortunate that the evidence on this point is clear so far as the quarry limestones are concerned, as in other parts of the district the relation of the limestone to the other beds is inverted; for instance, at a point about two and a half miles below Coimaidai, on the west side of the Pyrete valley, a section is exposed in which we find in descending order:—

(1) Basalt.

(2) Limestone, containing abundant freshwater shell casts, which, in the opinion of Mr. C. Hedley, F.L.S., are mostly of the genus Limnæa. One Bulimus was found.

(3) Clay, sand, gravel and conglomerate, merging into quartzite.

About a quarter of a mile higher up the quartzite is well developed and rests directly on the Silurian rocks.

The limestone in the above section is essentially of the same composition as the quarry limestone, being mainly carbonate of lime and magnesia, with a little silica, alumina and iron oxide. It is also very similar in physical appearance. Moreover, the gravels and quartzites overlying the limestone here cannot be distinguished in appearance from the similar beds seen near the quarries. It would thus appear that the limestone cannot be regarded as confined to one horizon. Mr. Ferguson, in the map above referred to, represents the quarry limestone as being overlain with a strong unconformity by the gravels, quartzites, etc. With this conclusion we do not agree ; the limestone must be regarded as part and parcel of the beds with which it is associated.

These deposits can be traced down the Pyrete Valley, outcropping just below the basalt ; and though they vary considerably in character from point to point, we have no doubt that they are continuous. As we leave Coimaidai and approach the Bacchus Marsh side of the basalt edge, the beds are found to be, as a rule, less highly cemented, and therefore looser and more incoherent.

On the Bacchus Marsh side, pipe-clays of a beautifully white colour and pure nature begin to appear. They are associated with considerable thicknesses of fine white sands, grits and gravels. Here and there a bed of hard conglomerate and thin lenticles of white, compact quartzite can be seen, intercalated with softer and even incoherent deposits. Near the Bacchus Marsh Road, and a short distance below the basalt, thin beds of limestone occur. This limestone is essentially of the same character as the quarry limestone, and its occurrence here is strong confirmatory evidence of the continuity of the beds of the Bacchus Marsh side of the district with those of Coimaidai. At a little distance from this limestone outcrop, and at a lower level, a section has been exposed in a road-cutting, in which we find in ascending order :—

(1) Gravel and sand, 5 feet.
(2) Thin band of white pipe-clay containing leaf impressions.
(3) Gravel and sand, showing much false bedding, 8 feet.

The leaf impressions are somewhat fragmentary, but of such distinctive character as to leave no room for doubt as to their significance. One impression is very similar to that of *Laurus* *werribeensis.* This band is at the lowest point in our series, the first appearance of limestone being about 130 feet above it. The relation of the Coimaidai series to the well-known Bacchus Marsh leaf beds is a point of great importance, especially as Messrs. Hall and Pritchard and Mr. C. Brittlebank have advanced strong evidence that the latter beds are at least of Eocene, if not of Cretaceous, age. Between the sands, gravels and ferruginous beds of varying character forming the Bacchus Marsh leaf beds and those of the Coimaidai area there is a very strong lithological resemblance. The absence of leaves from the Coimaidai series is, however, so marked a feature that, in our present knowledge of the facts, we are inclined to regard the Coimaidai series as lying above the Bacchus Marsh leaf beds. Except for the non-discovery of leaf-impressions, we have no evidence to show that there is a break or discontinuity between the Coimaidai and Bacchus Marsh series. On the contrary, our sections would seem to show that there is a gradual passage from the pipe-clay, in which we found our only leaf-casts, and which we regard as on the horizon of the Bacchus Marsh leaf beds, into the overlying series. In the Quarter-sheet of the Geological Survey, Section 12 N.E. Bacchus Marsh, a small part of the district we have been investigating is included, and here the infra-basaltic beds are mapped as identical with the leaf beds, a circumstance which corroborates the view we have taken of the mutual relations of the two series.

Before proceeding to discuss the physical condition which obtained during the formation of the Coimaidai beds, attention must be drawn to the existence of an ancient river-bed which has played an important part in determining the present contour and aspect of the country. The course of this river is, in the northern part of our district, mainly coincident in position with the tongue of basalt which separates the Pyrete and Goodman's Valleys. As it is a gold-bearing lead, many tunnels have been driven into it, and, both from the surface outcrops and the drifts exposed in the tunnels, we surmise that the river was of some magnitude. Some of the boulders of quartz seen by us are several feet in diameter, and well rounded and waterworn, as though they had travelled a considerable distance. The river course is through Silurian strata, and the river-drift is quartz and other rock of Silurian aspect. The existence of this river on the ridge between the deep valleys of the Pyrete and Goodman's Creeks testifies to the amount of denudation which nas taken place here in post-basalt times. The sides of the pre-existing valley of the river, which guided the basalt flow, have entirely disappeared at a point quite 500 feet above the creeks on either side of the ridge.

With respect to the physical circumstances under which the Coimaidai series was formed, it is clear that these beds accumulated under fresh water conditions, fluviatile and lacustrine. A large depressed area existed in the Bacchus Marsh district, in which was a lake resting on Silurian and Glacial beds. The shore line of the lake was doubtless irregular, and one large indentation extended up to the Coimaidai district. The deepest part of the lake was towards Bacchus Marsh, but in the region of the present valley of Coimaidai was a basin of considerable depth. Into this lake the ancient river previously referred to flowed in a southerly direction, accumulating, probably with the help of other streams, the masses of gravel and drift we now see. The main current of the river seems to have been towards the west side of the plain, although heavy boulder drift on the west of the Pyrete indicates that either a channel of the river came that way or marks the course of other creeks emptying into the lake. A spur of Silurian, probably forming a bold promontory, seems to have sheltered the Coimaidai Bay from the main flow of the river, and in this bay special conditions appear to have obtained. The regular stratification and fine lamination of the limestones imply fairly still water continuing during a considerable interval of time. Certain pit-marks, which may have been caused by rain, in the limestone suggest that there may have been variations of the level of the lake, by which expanses of the bed may have been exposed.

The limestone is a dolomitic travertin, and undoubtedly of chemical origin. Lime and magnesia, in solution in the waters of the lake, have been precipitated as carbonates, probably by springs of CO_2. In this context it may be mentioned that springs of CO_2 are at the present day abundant along the course of the Pyrete Creek, and in every case in which we have noticed them the bed-rock from which they issue has been either Glacial or Silurian. Their origin and maintenance would, therefore, appear to be quite unconnected with the decomposition of the limestone. The irregular and patchy distribution of the limestone is, therefore, what might have been expected on this view of their origin, as the springs would in all probability be quite local and even of an intermittent character. The band of ash found in the quarries suggests that the volcanic activity, which was manifesting itself during the deposition of the limestone, may not be unconnected with the development of the CO_2 springs. This point, however, we do not urge, in view of the fact that the springs still continue long after the cessation of the volcanic activity. It is, perhaps, worth while noticing in this context that the course of the Pyrete Creek roughly agrees with the strike of the Silurian rocks in this locality.

The intercalated bands at the quarry of sand and angular quartz gravel indicate that freshets occurred in the streams emptying into the lake in this region, and the fact that only isolated bones have been discovered suggests that the bones were brought down by streams to their final resting place.

The very hard quartzites appear to have been formed by the action of silicious springs. The microscopic examination of the rock strongly confirms this view ; in the slide rounded and subangular grains of quartz are set in a matrix of extremely minute specks of quartz, which acts as a cementing material. The peripheral markings of some of the quartz-grains may possibly be explained on the supposition that there has been a growth of the quartz by its taking up some of the silica in solution. There is a good deal of black dust, probably magnetite, scattered through the slide, and it is quite possible that, to some slight extent, the grains are bound together by a ferruginous cement. A few highly refracting and brightly polarising grains visible in the slide indicate, in all probability, the presence of zircons. There is no trace of felspar among the grains.

Only in this way do we think that the presence of hard, cherty quartzite in the midst of incoherent sand can be explained. The existence of wood opal in the river gravel supports the view that silicious springs occurred in the district. The sediments ultimately filled the Coimaidai basin and spread away to the eastward, where a wide extent of ferruginous sands and conglomerates form a more or less flat country, which extends to the Djerriwarrah Creek. Here the beds are found resting directly on the Silurian rocks.

With the exception of the basalt, the remaining post-glacial beds do not call for extended notice. Along the Goodman's Creek they are represented by a great development of boulder drift, often very heavy, and gravel. A ferruginous conglomerate is met with at different levels; the highest beds of this, which rest directly on the glacial rocks, are possibly continuous with those east of the Pyrete Creek. In the absence of fossil evidence, and having regard to the great variation of lithological character which marks the tertiary beds of this district, no attempt can be made to collate these beds with those lying further west.

On the south-east extremity of the basalt there is a thin capping of sand and water worn gravel, similar in composition and having the same level as the gravels found S. and S.E. of Bacchus Marsh, and well exposed in the Railway cutting S.E. of that town.

Basalt.—The point of eruption of the basalt flow was Mount Bullengarook, some seven miles to the north of the township of Coimaidai. The basalt is almost entirely confined to the area between the Goodman's and Pyrete Creeks, only one outcrop, and that a very small one, having been noticed by us west of the former creek, and no outcrop east of the latter creek. The basalt enters our district at an elevation of about 1100 feet above Coimaidai, and its thickness here is approximately 250 feet. At this spot it is about 300 feet wide, with a small slope to the south. This breadth is maintained fairly constant for a considerable distance south, but at a point on the Bullengarook Road, some 460 feet above Coimaidai, it rapidly narrows. At this place it is only forty feet wide and a few feet thick. Directly after leaving this spot, locally known as "The Neck," the basalt widens out into a broad plain, which, with a slight southerly slope, extends to the boundary of our area, where it has a thickness of between thirty and forty feet.

From its position and character we think that the basalt found west of the Goodman's Creek came from Mount Bullengarook. If this is so the creek must have eaten its way through some hundreds of feet of rock to attain its present level. Attention has been drawn to the connection between the basalt flow and the ancient river valley of the district.

The physical relations of the basalt to the other formations do not offer any points of particular interest. In places we have found the subjacent rock showing signs of metamorphism at its junction with the basalt. At a point a few yards east of Holloway's tunnel the basalt contains included pebbles of quartz and quartzite similar to those found in the river drift ; at the junction of the Coimaidai and Bullengarook Roads unrounded fragments of sandstone are found in it, while at its southern boundary it contains pieces of slate, etc.

A large number of specimens of basalt from different parts of the district have been prepared for microscopic examination. The general result of the examination shows that the rock may be classed as an olivine basalt with, however, a somewhat varying character. The specimens sliced from the neighbourhood of Coimaidai and south of Coimaidai contain large eroded crystals of felspar of allogenic origin, while olivine is somewhat subsidiary. As we proceed towards the northern boundary of our area the allogenic felspar disappears, and the rock becomes very rich in olivine. In other slides a further disappearance of authigenic felspar may be noticed until the rock assumes the type of limburgite. Some of the specimens have been tested for titaniferous iron, but with a negative result.

In macroscopic structure the basalt shows the usual variability, passing by stages from a hard, dense rock into the vesicular form. Magma-basalt, much weathered, was found near the limburgite.

Slide No. 1 is cut from basalt taken from the eastern edge of the plateau, about a quarter of a mile due west from the township of Coimaidai. In appearance it is a dense rock, of bluish-black colour, breaking with a somewhat hackly fracture. Porphyritic crystals of felspar, olivine and secondary calcite may be seen by the naked eye. Under the microscope the rock is seen to possess a hyalopilitic structure ; there is a considerable amount of glass or isotropic matter present, which has in natural light a faint brown colour. The other minerals present are triclinic felspar, augite, olivine, magnetite and secondary calcite. The felspar occurs in two distinct forms, of allogenic and authigenic origin. The allogenic felspar is present as large phenocrysts which have suffered much erosion; around them the lath-like felspars of authigenic origin are arranged in flow-structure. In natural light the allogenic felspar is seen as a clear and colourless material, containing inclusions of a light brown colour, and magnetite. As these inclusions are isotropic in character, it would appear that during the intra-telluric stage in the history of the crystal the solvent action of the magma produced a honeycomb structure in the felspar, and that the cavities so produced were filled with basalt glass, from which the magnetite has subsequently crystallised out In one phenocryst both the glass inclusions and the magnetite appear arranged in lines along the twinning planes. The phenocrysts show twinning according to both the albite and pericline laws; but no sections are present in the slide from which measurements could be taken to determine the nature of the felspar. The authigenic felspar occurs in sections of short, broad prisms and in lath-like forms, which are sometimes frayed out at one end. From measurements taken by us, this felspar is probably labradorite. Augite is moderately represented in the slide; it occurs mainly in allotriomorphic crystals, which often form nests or clusters. These clusters give a striking appearance to the slide. The masses of augite are destitute of crystal boundaries; their composite character is shown by the fact that, under polarised light, different parts of the aggregation do not obscure simultaneously. These clusters contain numerous, somewhat large, grains of magnetite. In this slide there is a good example of twinned augite showing the hour-glass structure. Olivine is fairly abundant as hypidiomorphic crystals and as grains wedged in between the lath-like felspars; it is, for the most part, decomposed into a light green chloritic or serpentinous material. The magnetite and calcite do not call for any special remark. The order of crystallisation of the constituent minerals appears to be allogenic felspar, magnetite, augite and olivine, authigenic felspar and secondary calcite.

Slide No. 2 represents the typical basalt of the tongue-like mass lying between the Pyrete and Goodman's Creeks. It has been prepared from a specimen taken about half a mile north of "the Neck." It has a fine-grained matrix, studded with porphyritic crystals and blebs of olivine. The rock is microscopically holocrystalline, approaching to a pilotaxitic structure. The constituent minerals are felspar, olivine, augite and magnetite. The felspar is in lath-like forms, having their longer axes arranged in more or less parallel lines ; there is some trace of flow structure round the larger phenocrysts of olivine and augite. Olivine is very abundant in the slide, appearing both as allotriomorphic crystals and as grains. The crystals are large and almost entirely free from decomposition. Augite is less abundant than olivine ; it occurs in allotriomorphic crystals, rounded masses and clusters. Magnetite is seen in large quantities, as minute specks often forming a wreath or border round the outer edges of the phenocrysts, as small grains, and in large masses presenting certain peculiar features. One of these masses is not unlike a semi-circle in shape, the side corresponding to the diameter of the semi-circle is between ·02 and ·03 of an inch long, and is a fairly straight line, while the curved edge is deeply fretted and has a lattice-like structure, the minute areas bounded by the thin films of magnetite contain anisotropic matter, probably a devitrified glass.

Slide No. 3 is from a specimen taken from a small outcrop in Langmuir's paddock, about two miles W.N.W. of Coimaidai. This outcrop is the only one found by us west of the Goodman's Creek. Macroscopically it is very similar in appearance to the rock last described, porphyritic crystals of augite, decomposed olivine and a reddish-brown mica may be seen by the naked eye. The base may be classed as hypocrystalline, being made up mainly of grains of magnetite and augite, with residual glass. The minerals present are augite, olivine and magnetite. Felspar is almost entirely, if not quite, absent. Augite is abundant in well preserved idiomorphic crystals, often showing zonal structure. A peculiar feature is exhibited by some of the augite phenocrysts. When the stage of the microscope is rotated between crossed nicols, the crystal is seen to be composite in character, there being a central area and a peripheral area ; the boundary of the central area does not conform to that of the crystal, and the two areas do not obscure simultaneously. The cleavage lines of the inner and outer areas are continuous. The appearance presented is quite dissimilar from that of normal zonal structure, and points to considerable discontinuity in the growth of the crystal. Other augite phenocrysts present peculiarities of another kind ; there is an inner area, often with ragged, uneven boundary, which is clear and colourless in plane light ; this is enclosed in a border of a light brown colour and of varying breadth ; the whole is enclosed in augite showing good crystal outlines. The inner area does not, in general, obscure with the outer area ; it is more highly refracting. The enclosed material is in all probability an eroded augite crystal. Most of the augite crystals show accumulations of black specks towards their central parts. Olivine is present in large crystals, but has suffered much decomposition ; the replacing material is light green in colour and sometimes faintly pleochroic. When decomposition has advanced very far the olivine has been entirely converted into a serpentinous material. There is no mica present in the slide ; in another slide, procured near Mount Bullengarook, there are small patches of a reddish-brown mica, pseudomorph after olivine, which may possibly be rubellan. The mica seen on the surface of the rock from which this slide has been cut appears to occupy a cavity in an olivine crystal. The residual glass is in places traversed by long, colourless, acicular rays. Beyond the fact that they are a common constituent of basalts all over the globe, nothing definite appears to be known of them. Zirkel, in his "Microscopic Petrography of the Fortieth Parallel," regards them as an undetermined product of devitrification. Having regard to the basic character of the rock and the absence of felspar crystals, we have no hesitation in calling it limburgite. The previous occurrence of this mineral in Victoria has been noticed by Mr. A. W. Howitt in a dyke in the No. 180 Mine, Bendigo.

ART. VIII.—*The Spectra of the Alkalies and their Atomic Weights.*

By L. RUMMEL.

[Read 10th June, 1897].

In a paper read before the Royal Society of Victoria in November last year, I introduced the formula $\lambda = x + \frac{y}{n^2 - z}$, by which to express the relationship of several spectrum lines of the same metal. The three constants x, y and z I determined from three successive wave lengths, n being assumed a round number and found experimentally. In order to test the validity of the last assumption and to effect a better accordance between the experimental and the calculated values, I have added a fourth wave length and determined the value of n by an additional equation. If a, b, c and d are the numbers representing the wave lengths of four successive spectrum lines of a series, their relations may be expressed as follows:

$$a = x + \frac{y}{n^2 - z}$$

$$b = x + \frac{y}{(n+1)^2 - z}$$

$$c = x + \frac{y}{(n+2)^2 - z}$$

$$d = x + \frac{y}{(n+3)^2 - z}$$

and their constants found by the four equations:

$$1. \quad x = a - \frac{y}{n^2 - z}$$

$$2. \quad y = \frac{(a-b)(n^2 - z)[(n+1)^2 - z]}{2n+1}$$

$$3. \quad z = n^2 - \frac{(b-c)(2n+1)(4n+4)}{(a-b)(4n+4) - (a-c)(2n+1)}$$

$$4. \quad n^2 + 3n = \frac{27\alpha - 32\beta}{16\beta - 12\alpha}$$

$$\text{if } \alpha = a - c \text{ and } \beta = \frac{(a-d)(b-c)}{b-d}$$

The fourth equation, being quadratic, yields two values, the lesser one applying to the first and the larger one to the fourth member of the series.

The value of n may also be found by approximation, viz., by substituting successively probable values for n into equation No. 3, until the most satisfactory results are obtained. Both methods may be employed, the first when the experimental data are very correct, the latter in doubtful cases.

The values of n, x, y and z, determined from the experimental data for the alkalies and Helium, are contained in the table of spectral constants given below, from the study of which the following results have been derived.

Calling x the root and n the modulus, and denoting the principal series by a, a^1 and a^2, the subordinate series by b, b^1, b^2 and c, c^1, c^2, I have arrived at the propositions:—

1. Each element has two roots for its four subordinate series, and two, possibly only one, for its two head or principal series.

2. The modulus of the subordinate series b, b^1, b^2 is a round number, of the coordinate series c, c^1, c^2 a fractional value.

I propose to call the series b, b^1, b^2 the normal, the series c, c^1, c^2 the abnormal one.

3. The atomic weights are directly proportional to the square roots of the difference of the roots (x) of the subordinate series.

In the following little table the first line contains the difference of the roots of the subordinate series for each element; the second, the square roots of these numbers; the third, the atomic weights, and the fourth, the atomic weights divided by the square roots.

Helium.	Li.	Na.	K.	Rb.	Cs.
·10	—	4·0	11·53	54·86	134·7
·316	—	2.0	3·395	7·406	11·61
4 ?	7	23	39	85·2	133
12·65 ?	—	11·5	11·49	11·5	11·46

The constancy of the last line for the alkalies proves the proposition.

Whether the two head series start from a single root or not is a point I have, so far, not been able to settle. The data to hand are not sufficiently precise, or the series too short. The modulus advances in value with the atomic weight, viz., Helium = ·94;

Li = ·96; Na = 1·2; K = 1·44; Rb = 1·57 and 1·61; Cs (probably) = 1·75.

Mr. William Sutherland, who most kindly volunteered to assist me in drawing up my report, and has also kept me informed of the latest intelligence bearing on this paper, has discovered the following remarkable relation, communicated to me in these words:—

"If you take your series of numbers

·96   1·2   1·44   1·57 and 1·61   1·75

and write their differences you get

·24   ·24   ·13 or ·17   ·18 or ·14

while the differences of atomic weights are

16   16   46   48

whose square roots are nearly inversely proportional to the previous numbers."

My second proposition leads to a considerable simplification in the process of evolving the constants. After first having ascertained which of the series is the normal, *i.e.*, yields precise results with three constants only according to equation No. 3, the roots thus obtained lead to the determination of the moduli of the co-ordinated abnormal series. If a, b and c are three successive wave lengths with their roots subtracted, the modulus is found by the equation—

$$n = \frac{4\left(\frac{a}{b} - 1\right) - \left(\frac{a}{c} - 1\right)}{2\left(\frac{a}{c} - 1\right) - 4\left(\frac{a}{b} - 1\right)}$$

My constants have been obtained from three wave lengths only for the normal series, excepting the series b^1 of Sodium, where discrepancies exceeding the probable limit of error of observation induced me to harmonise my results by rejecting the third wave length and employing in its stead a mean value derived from the other members of the series.

For the ultrared rays of Lithium and Sodium I have adopted the very accurate numbers found by E. P. Lewis, in preference to those of Kaiser and Runge. Swan's numbers for the same part of the spectrum in regard to Potassium, Rubidium and Caesium can only be considered as widely approximative. The spectra of the two last named metals are, in my opinion, incomplete; Rubidium wanting another pair of abnormal series for its completion, and Caesium a pair of normal series. This may account for some discrepancies in my table of wave lengths and likewise reinstate several wave lengths rejected in my first paper.

The atomic weights, taking Sodium = 23, may be calculated from proposition No. 3 as follows:—Helium = 3·64; Na = 23; K = 39·05; Rb = 85·15; Cs = 133·47. Kaiser and Runge calculated the atomic weights from the differences of the vibration numbers and obtained the values, viz., Na = 23; K = 40·6; Rb = 82·6; Cs = 126.

I may state here that the same proportionality prevails in the second group of elements, and even in the other groups, where series have been discovered. In the case of triplets the first and the third wave length yield the proportional value. My investigations on those groups have, however, not been concluded. I, therefore, refrain from giving the numbers.

Rydberg's proposed law connecting the roots of the subordinate series with the headlines and root of the principal series, although not strictly true for Helium and Potassium, I have made use of for the approximate determination of the modulus of the head series of Caesium.

T. Balmer has quite recently published a formula similar to mine with three constants. Its application to the Helium lines shows good accordance, excepting the c^1 and c^2 series, where it fails to the extent of more than 10 Angstroem units. His paper is published in Wiedemann's Annalen der Physik and Chemie. The same periodical is the source from whence the experimental data of my paper have been derived, except the Helium series, which have been published by Runge and Paschen in the Sitzungsberichte der Academie in Berlin last year.

In my table of wave lengths the experimental values and the calculated ones are placed one above the other, those on a line with E, E being the numbers derived from observations and corresponding to those immediately above.

If I may allow myself any conjectures regarding the nature of the curves and the origin of the spectrum lines, I consider the curves to belong to the conical order—hyperbolas in preference —while the lines are caused by the interference of two light waves, the distance of one line from the next following being consistently $2n + 1$.

TABLE OF WAVE LENGTHS I.

	HELIUM.						LITHIUM.			SODIUM.					
n+	a^1	a^2	b^1	b^2	c^1	c^2	*a*	*b*	*c*	a^1	a^2	b^1	b^2	c^1	c^2
1	10930·39	10933·63	57516	57494	7065·77	7065·51	6708·2	93892	8124·26	5896·16	5890·19	8194·2	8183·7	11392·26	11380·06
E	11200	11200	Not Observed.	Not Observed.	7065·77	7065·51	6708·2	Not Observed.	8126·3	5896·16	5890·19	8194·2	8183·7	11403·9	11381·1
2	3888·97	3888·76	5876·206	5875·883	4713·39	4713·17	3232·77	6103·77	4972·11	3303·07	3302·47	5688·26	5682·90	6161·15	6154·62
E	3888·97	3888·76	5876·206	5875·883	4713·39	4713·17	3232·77	6103·77	4972·11	3303·07	3302·47	5688·26	5682·90	6161·15	6154.62
3	3187·94	3187·78	4471·85	4471·66	4121·13	4120·89	2741·39	4602·37	4273·44	2852·91	2852·91	4983·94	4979·30	5153·72	5149·19
E	3187·98	3187·83	4471·85	4471·66	4121·15	4120·98	2741·39	4602·37	4273·44	2852·91	2852·91	4983·53	4979·30	5153·72	5149·19
4	2945·35	2945·22	4026·55	4026·40	3867·81	3867·60	2562·65	4132·44	3985·94	2680·50	2680·62	4670·02	4665·66	4752·19	4748·36
E	2945·35	2945·22	4026·52	4026·35	3867·77	3867·61	2562·60	4132·44	3985·94	2680·46	2680·46	4669·4	4665·2	4752·19	4748·36
5	2829·31	2829·20	3819·94	3819·82	3733·20	3733·01	2475·26	3915·36	3835·96	2593·96	2594·25	4499·22	4495·08	4545·65	4542·01
E	2829·32	2829·16	3819·89	3819·75	3733·15	3733·01	2475·13	3915·2	3838·3	2593·98	2593·98	4500·0	4494·3	4546·03	4542·75
6	2764·01	2763·91	3705·31	3705·19	3652·31	3652·14	2425·55	3795·22		2543·89	2544·25	4394·92	4390·75	4423·87	4420·24
E	2764 01	2763·91	3705·29	3705·15	3652·29	3652·15	2425·55	3794·9		2543·85	2543·85	4393·7	4390·7	4423·7	4420·2
7	2723·37	2723·27	3634·53	3634·41	3599·62	3599·47	2394·40	3721·12		2512·13	2512·55	4326·07	4322·05	4345·45	4341·83
E	2723·3	2723·3	3634·52	3634·39	3599·59	3599·45	2394·54	3718·9		2512·23	2512·23	4325·7	4325·7	4343·7	4343·7
8	2696 26	2696·18	3587·54	3587·42	3563·27	3563·13	2373·55	3671·98							
E	2696·5	2696·5	3587·54	3587·42	3563·26	3563·11	2373.9	3670·6							
9	2677·25	2677·17	3554·67	3554·56	3537·09	3536·96	2358·87								
E	2677·1	2677·1	3554·5	3554·5	3536·9	3536·9	2359·4								
10			3530·74	3530·63	3517·58	3517·45									
E			3530·6	3530·6	3517·5	3517·5									
11			3512·75	3512·64	3502·64	3502·51									
E			3512·6	3512·6	3502·5	3502·5									
12			3498·87	3498·77	3490·93	3490·82									
E			3498·7	3498·7	3490·8	3490·8									
13			3487·94	3487·84	3481·59	3481·48									
E			3487·8	3487·8	3481·5	3481·5									
14			3479·17	3479·07											
E			3479·2	3479·2											

TABLE OF WAVE LENGTHS II.

	POTASSIUM.						RUBIDIUM.				CAESIUM.			
$n+$	a^1	a^2	b^1	b^2	c^1	c^2	a^1	a^2	b^1	b^2	a^1	a^2	c^1	c^2
1	7699	7666	10905	10844	11227	11115	7948·46	7810·00	14270·6	13590·8	8905·08	8495·73	36870	29783
E	7699	7666	10860	10860	12200	11550	7950	7811	14750	13180	9000	8330	Not Observed.	Not Observed.
2	4047·36	4044·29	6936·54	6909·00	6903·26	6874·91	4215·72	4201·98	7724·88	7586·06	4593·34	4555·44	9172·60	8751·38
E	4047·36	4044·29	6938·5	6911·2	Not Observed.	Not Observed.	4215·72	4201·98	Not Observed.	Not Observed.	4593·34	4555·44	9000	8820
3	3447·49	3446·49	5832·23	5812·54	5802·01	5782·67	3591·74	3587·23	6298·70	6206·7	3888·83	3876·73	6973·9	6723·6
E	3447 49	3446·49	5832·23	5812·54	5802·01	5782·67	3591·74	3587·23	6298·70	6206·7	3888·83	3876·73	6973·9	6723·6
4	3217·92	3217.42	5359·88	5343·35	5340·08	5323·55	3351·03	3348·86	5724·41	5648·18	3616·75	3611·84	6213·4	6010·6
E	3217·76	3217·27	5359·88	5343·35	5340·08	5323·55	3351·03	3348·86	5724·41	5648·18	3616·75	3611·84	6213·4	6010·6
5	3102·30	3102·05	5112·68	5097·75	5099·64	5084·49			5431·83	5362·94			5845·1	5664·0
E	3102·37	3102·15	5112·68	5097·75	5099·64	5084·49			5431·83	5362·94			5845·1	5664·0
6	3035·02	3034·88	4966·68	4952·69	4957·77	4943·46			5261·50	5196·68			5634·96	5466·16
E	3034·94	3034·94	4965·5	4952·2	4956·8	4943·1			5259·8	5194·8			5635·1	5465·8
7	2992·14	2992·06	4873·11	4859·72	4866·82	4853·06			5153·31	5090·99			5502·52	5341·56
E	2992·33	2992·33	4870·8	4856·8	4863·8	4850·8			5161·8	5085·8			5501·9	5345·9
8	2963·01	2962·98	4809·50	4796·51	4804·90	4791·54			5080·18	5019·50			5412·43	5257·63
E	2963·36	2963·36	4808·8	4796·8	4803·8	4788·8			5085·8	5021·8			5410·9	5257·8
9	2942·27	2942·28			4761·25								5349·91	
E	2942·8	2942·8			4759·8								5345·9	
10													5303·34	
E													5310·8 ?	

TABLE OF SPECTRAL CONSTANTS.

ELEMENT.		n	x	y	z	ELEMENT.		n	x	y	z
Helium	a^1	·94	2599·66	7443·873	2·8701	Potassium	a^1	1·44	2853·53	9314·66	4·0313
,,	a^2	·94	2599·59	7442·36	2·8706	,,	a^2	1·44	2853·66	9302·45	4·0206
,,	b^1	1·00	3421·05	12859·4	3·76228	,,	b^1	1·00	4573·86	18845·97	1·02348
,,	b^2	1·00	3420·95	12858·486	3·76220	,,	b^2	1·00	4562·33	18730·16	1·01841
,,	c^1	1·715	2421·05	12877·00	3·83817	,,	c^1	1·1332	4573·86	18876·835	1·71238
,,	c^2	1·715	3420·95	12873·37	3·83901	,,	c^2	1·11	4562·33	18655·03	1·60535
Lithium	a	·96	2298·55	5831·92	2·519065	Rubidium	a^1	1·57	2963·13	10271·7	4·5445
,,	b	1·00	3498·11	13414·95	3 851606	,,	a^2	1·61	2962·21	10361·06	4·6748
,,	c	1·60	3498·11	13412·265	3·86077	,,	b^1	1·00	4812·17	21251·86	1·70375
Sodium	a^1	1·20	2411·42	6470·51	2·9932	,,	b^2	1·00	4757·31	20806·6	1·64458
,,	a^2	1·20	2411·96	6463·6	2·9817	Caesium	a^1	1·75	3172·56	12275·3	5·4207
,,	b^1	2·00	4085·65	18394·2	4·5230	,,	a^2	1·75	3176·01	12105·1	5·2870
,,	b^2	2·00	4081·66	18385·5	4·5180	,,	c^1	1·50	5081·30	28173·76	5·3637
,,	c^1	1·65	4085·65	18263·58	4·5229	,,	c^2	1·40	4946·58	25988·5	4·73526
,,	c^2	1·67	4085·66	18356·3	4·6138						

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CONTENTS OF VOLUME X.

PAGE

Art. IX.—Contributions to the Palæontology of the Upper Silurian Rocks of Victoria, based on Specimens in the Collections of Mr. George Sweet. Part I. By W. S. Dun. (Pate III.) 79

X.—On Entropy Meters. By E. F. J. Love, M.A., F.R.A.S. (With Diagram) 91

XI.—On a Method of Determining the Specific Heat of a Liquid, especially of Solutions. By Walter Rosenhain. (With two Diagrams) 97

XII.—Description of a New Species of Unio from the River Glenelg. By J. Dennant, F.G.S. (Plate IV.) 112

XIII.—Observations on Muridæ from Central Australia. By Edgar R. Waite, F.L.S. (Plates V. and VI.) 114

XIV.—The Miocene Strata of the Gippsland Lakes Area. By J. Dennant, F.G.S., and D. Clark, B.C.E. (Plate VII.) 129

XV.—On a New Species of Victorian Mollusc (Coralliophila wilsoni). By G. B. Pritchard and J. H. Gatliff 140

XVI.—Notes on Certain of the Initiation Ceremonies of the Arunta Tribe, Central Australia. By Professor Baldwin Spencer, M.A., and F. J. Gillen 142

XVII.—Stylasteridæ from the Victorian Tertiaries. By T. S. Hall, M.A. 175

XVIII.—The Geology of Coimaidai. Part II. The Silurian and Glacial Beds. By Graham Officer, B.Sc., and Evelyn G. Hogg, M.A. With Appendices by C. W. De Vis, M.A., and T. S. Hall, M.A., on the Marsupial Bones of the Coimaidai Limestone and the Graptolites of the District respectively (Plates VIII. and IX.) 180

PAGE

XIX.—The Northward Extension of the Derrinal Conglomerate (Glacial). By E. J. Dunn, F.G.S. ... 204

XX.—Note on Perforated Rocks from West Australia. By E. J. Dunn, F.G.S. 209

XXI.—The Structure of an Australian Land Leech. By Ada M. Lambert, M.Sc. (Plates X.-XIV.) ... 211

XXII.—Catalogue of the Marine Shells of Victoria. Part I. By G. B. Pritchard and J. H. Gatliff ... 236

XXIII.—Note on an Additional Genus of Fossil Plants found in the Bacchus Marsh Sandstone by George Sweet, Esq., F.G.S. By Sir Frederick McCoy, K.C.M.G., M.A., D.Sc., F.R.S., etc. 285

Annual Report of the Council, 1896 287

Balance Sheet for 1896 290

List of Members, &c. 292

List of Institutions and Learned Societies which Receive Copies of the Society's Publications 299

Art. IX.—*Contributions to the Palæontology of the Upper Silurian Rocks of Victoria, based on Specimens in the Collections of Mr. George Sweet. Part I.*

By W. S. Dun.

(Plate III.)

[Read 11th March, 1897.]

Some little time ago Mr. George Sweet of Brunswick, Victoria, placed in the hands of Mr. R. Etheridge, Junr., a collection of Victorian Silurian Fossils for determination. Shortly after this Mr. Etheridge was appointed to the position of Curator of the Australian Museum, and, being unable to devote the necessary time to this work, he suggested that I should take it up, with which suggestion Mr. Sweet generously agreed. The first part of this work is now ready, consisting of the descriptions of the corals contained in limestones and shales in the Mansfield and Kilmore districts. As a rule these forms are imperfectly preserved as shale casts, especially is this the case in the specimens from Kilmore, some of the Mansfield specimens being in a more determinable condition in limestone.

The forms contained in the collection are :—

Favosites gothlandica, Lamarck.
Pleurodictyum, sp.
Cyathophyllum elegantulum, n.sp.
Cyathophyllum Mansfieldense, n.sp.
Petraia, sp.
Monotrypa, sp.

Though this fauna is small, still it is sufficiently definite to determine the beds as of Upper Silurian age. The ranges of the different species and genera will be found mentioned later on.

The descriptions and records of Palæozoic Corals in Victoria are very scanty, there being descriptions of two forms only, *Favosites goldfussi*, D'Orb., from the beds classed as Middle

Devonian, Buchan, by Sir Frederick McCoy[1] and *Favosites grandipora*, Eth. fil., by Mr. R. Etheridge, Junr., from the Lilydale Limestone.[2] Sir Frederick records *F. goldfussi* also from Cooper's Creek, Thompson River,[3] associated with corals of species allied to *Cyathophyllum cæspitosum*, *Trematopora ostiolata*, Hall, and *Cladopora fibrosa*, Hall, and the same species of *Trematopora* from Deep Creek, on the Thompson River. *Favosites fibrosa*, Goldfuss, is recorded from Upper Silurian rocks at Jamieson,[4] and also from an Upper Silurian sandstone ridge between Whroo and Coy's Diggings.[5] *Heliolites interstinctus*, Linn., has been collected from Upper Silurian beds at Waratah Bay,[6] and also from a locality five miles E.N.E. of Redcastle.[7] *Pleurodictyum megastomum*, McCoy (M.S.), a form with which our *Pleurodictyum* sp. probably is identical, is mentioned in Sir Frederick's Essay on the Natural History of Victoria as occurring in the Upper Yarra District.[8] This form is also quoted by Roemer.[9] *Stromatopora concentrica*, Goldfuss, is mentioned as occurring in the Devonian limestones of Bindi.[10] Mr. Etheridge also records the occurrence of three distinct species of *Stromatopora* from the Wenlock (Upper Silurian) limestone of Lilydale.[11] From the same locality Mr. Cresswell notes *Heliolites*, sp., and *Cyathophyllum*, sp.[12] Sir Frederick McCoy also mentions[13] the occurrence of new species of fossil corals at Waratah Bay, but gives no clue as to what they are. Species of Petraia have also been recorded from Kal Kal[14] and Kilmore[15] by McCoy.

Judging from the meagre collections that have hitherto been made it would appear that the Palæozoic coral fauna was not so well developed in Victoria as in New South Wales and Queensland, but as so many of the limestones and associated shales appear to be favourable to the preservation of their remains, it is probable that systematic collecting will add more forms. It seems strange that in Mr. Sweet's large collections from Kilmore and Mansfield there are no traces of *Heliolites* and so few specimens of other forms.

---

[1] Prod. Pal. Vict., 1876, Dec. 4, p 15, t. 35, f. 1.

[2] Records Austr. Mus., 1890, i., p. 61, t. 8, f. 6-9.

[3] Prog. Rept. Geol. Survey Vict., 1878, p. 175.

[4] *Op. cit.*, 1877, p. 157.

[5] *Op. cit.*, 1878, p. 174.

[6] *Op. cit.*, 1877, pp. 156, 158.

[7] *Op. cit.*, p. 158.

[8] Ann. Mag. Nat. Hist., 1867, xx., p. 201.

[9] Lethæa Geognostica, 1883, i., Lief. 2, p. .

[10] Prog. Rept. Geol. Survey Vict., 1877, p. 158.

[11] Records Austr. Mus., 1890, i., p. 60.

[12] Proc. R. Soc. Vict., 1893, v. (N.S.), p. 41.

[13] Ann. Rept. Dept. Mines Vict. for 1894 [1895], p. 18.

[14] Geol. Survey Vict., Quarter-sheet 3 S.W.

[15] Geol. Survey Vict., Quarter-sheet 4 N.W.

In the preparation of these notes I have often availed myself of Mr. R. Etheridge's wide experience among Palæozoic corals.

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Class—Actinozoa.
Order—Zoantharia.
Sub-Order—Z. Sclerodermata.
Section—Perforata.
Family—Favositidæ.
Genus—Favosites, Lamarck, 1816.
(Histoire Anim. sans Vert., ii,, p. 204.)

Favosites gothlandica, Lamarck.

(For general synonymy see Nicholson, Tabulate Corals, 1879, p. 46; for references to records of occurrences of this species and of its variety *F. goldfussi*, D'Orb., in Australia, see R. Etheridge, Junr., Catalogue of Australian Fossils, 1878, pp. 12, 36.

Favosites gothlandica, Nicholson and Etheridge, Ann. Mag. Nat. Hist., 1879, iv., p. 209. R. M. Johnston, Geol. Tasmania, 1888, t., ii., f. 14. R. Etheridge, Junr., Geol. and Pal. Queensland, 1892, p. 50, t. iii., f. 1-5.

In the collection there are several specimens of *Favosites* which can safely be referred to this cosmopolitan species, the size of the corallites, the arrangement of the tabulæ, and the general appearance being similar to those characteristics as developed in this protean form. I group together under this head two forms, in one of which the corallites are larger than in the other, but taking into consideration Professor Nicholson's remarks[1] on this subject and allowing for the fact that in neither case are the mural pores visible, nothing would be gained by their separation.

---

[1] Tabulate Corals, pp. 46-56.

Some of the specimens have strongly concave and slightly irregular tabulæ. For the same reason it would be perhaps better to consider Sir Frederick McCoy's *F. goldfussi,*[1] as he himself remarks, as a synonym of *F. gothlandica*, as Nicholson has done in the case of European specimens. The latter author remarks:[2] 'As has been previously said, *F. gothlandica* was regarded by Milne-Edwards and Haime as essentially a Silurian species, and the corresponding Devonian forms were separated by them under the name of *F. Goldfussi.* This latter species is separated by its authors from *F. gothlandica* simply upon the ground that its corallites are said to be larger, and that the mural pores are more closely set than in the Silurian form. The size of the tubes (one and a half line) is, however, frequently exceeded by typical Upper Silurian examples of *F. gothlandica*, and under any circumstances cannot be regarded as a character of the smallest specific value, while the mural pores exhibit at least an equal variability. I am, therefore, quite unable to accept the separation of *F. Goldfussi* from *F. gothlandica.*"

There can be no benefit derived from classing the forms in different species according to the Australasian horizons they come from, as the variations are as great here as in the Old World. It would, I think, therefore, be better to consider all forms coming under the wide specific range allowed by Nicholson as Australian representatives of *F. gothlandica.*

The species occurs in Victoria in rocks classed as Upper Silurian and Devonian. In Queensland the limestone of the Broken River (Burdekin), which has been classed by Messrs. Jack and Etheridge as Middle Devonian, and which may perhaps be correlated with the Siluro-Devonian Limestones of New South Wales, as has already been remarked by Mr. R. Etheridge, Junr. In New South Wales it is extremely common and variable and occurs in Upper Silurian, Siluro-Devonian, and the Moonbi Limestones which have been lately referred by Professor David to the Devonian.

---

[1] Prod. Pal. Vict., 1876, Dec., iv., p. 15, t. 35, f. 1-1*d*.

[2] *Loc. cit.*, p. 54.

Genus—Pleurodictyum, Goldfuss, 1829.

(Petrefact. Germaniæ, i., p. 113).

Pleurodictyum, sp. (? **P. megastomum**, McCoy, M.S.)

(Pl. III., Fig. 1).

In the collection there are two specimens of casts of this coral from Kilmore and several from the Mansfield district. They occur solely as casts, and though there can be no doubt as to the generic position, it would be difficult to assign specific characters to them. The most perfect specimen is from Kilmore, and shows impressions of nine polygonal calices and a portion of a tenth. These form a more or less circular corallum. Extending across it there is an irregular depression, which may possibly represent the impression caused by the vermiform body, and would point to the fact that we have before us the basal portion of the corallum, especially as the corallites are radiating outwards. The cell walls have been dissolved away, and their position is shown by spaces traversed by bars representing the infilled mural pores, so that we have only an internal cast presented. The walls have been thick and the septa numerous and represented by broken ridges, pointing to the fact that the septa in the original condition were present as rows of spines rather than as regular ridges. The mural pores are large, irregularly spaced and numerous, as represented by the bars before mentioned. The tabulæ are slightly arched and not perfectly smooth, but covered with numbers of small pits representing in the original a slightly pustulose or spinous appearance. The largest tabula has a width of $\frac{13}{40}$ of an inch. The specimen from Kilmore showing the ten corallites has a diameter of $\frac{17}{20}$ of an inch.

From this short description it will be seen that there is very little to go on as far as specific delimination is concerned. Sir Frederick McCoy has recorded[1] a form as *Pleurodictyum megastomum* from the Upper Silurian of the Upper Yarra District, but so far as I am aware does not describe it. It is quite possible that our form and this are one and the same.

---

[1] Ann. Mag. Nat. Hist., 1867, xx., p. 201.

As compared with European species, and taking first *P. zorgense*, Kayser,[1] from Sprakelsback in the Lower Devonian of the Harz, the corallites of our form appear to be larger, the mural pores more numerous and the septal spines more developed. Compared with *P. selcanum*, Siebel, as figured by Kayser,[2] the corallites are again much larger, but the nature of the septa differs radically and the pores are not so regular. From the well-known *P. problematicum*, Goldfuss, it is also separated by the difference of size of the corallites, the number of mural pores and the septal condition.

There is a very close connection between the genera *Pleurodictyum* and *Michelinia*, and it is possible, as pointed out by Professor H. Alleyne Nicholson, that these two genera will eventually be united. At present corals of this type occurring in Upper Silurian and Lower Devonian beds are referred to *Pleurodictyum*, whilst corals of a somewhat similar type occuring in higher Devonian and Carboniferous strata are classed under *Michelinia*. A very full discussion of the relations of these two genera will be found in Professor Nicholson's works,[3] and also in a paper by Professor Julien Fraipont.[4]

As regards the American forms it seems to approach nearest to *P. stylophorum*, Eaton,[5] from the Hamilton Group (Middle Devonian).

Taking all these facts into consideration, there seems to be no alternative but to class these specimens as *Pleurodictyum*, leaving the specific determination till more perfect specimens are available.

I have seen in the Upper Silurian (Wenlock) rocks of Yass, New South Wales, a *Pleurodictyum* having every appearance of the Victorian form, even as to preservation. Mr. John Mitchell has also recorded[6] the occurrence of *Pleurodictyum* in the Bowning Beds of the same district, associated with *Calymene Blumenbachii*,

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[1] Abhand. Geol. Specialkarte Preus. u. Thuring. Staat., 1878, ii., Heft 4, p. 229, t. 33, f. 9, 10.

[2] *Loc. cit.*, p. 227, t. 33, f. 8, 8a, ? 11.

[3] Tabulate Corals, pp. 141-143, 151, 152; Man. Pal., 1889, i., pp. 316-318.

[4] Sur les affinités des genres Favosites, Emmonsia, Pleurodictyum et Michelinia a l'occasion de la description d'une forme nouvelle de Favositide du calcaire carbonifère supérieur. Ann. Soc. Geol. Belge, 1888, xvi., p. 21-32, t. 1.

[5] Nicholson, *loc. cit.*, p. 145, t. 22, *c* and *d*.

[6] Proc. Linn. Soc. New South Wales, 1887, ii. (2), p. 412.

Acidaspis, *Cromus*, *Turrilepas*, etc. He says the "specimen has cells over half an inch in diameter, and the whole specimen measures two inches across," and surmises that it may be the same as Sir Frederick McCoy's *P. megastomum*. I have recorded[1] a species from near Fifield, New South Wales, and in the Mining and Geological Museum, Sydney, are specimens preserved in a ferruginous grit from Sebastopol showing very large corallites.

Pleurodictyum is usually considered to be a Devonian fossil, but it is possible, according to Nicholson's remarks, that many of the species of *Michelinia* described by Rominger from the Niagara (Upper Silurian) Beds of N. America, may be *Pleurodictyum*. The horizon of *P. zorgense* and *P. selcanum* is in beds which are considered by some to be Lower Devonian, though perhaps it would be better to consider them as passage beds—equivalents of those called by Dr. J. M. Clarke the Helderbergian of North America and the Hercynian of Europe.[2] So, though *Pleurodictyum* by itself may not be a very definite index of Upper Silurian age, still in its association with forms such as those occurring at Kilmore, Mansfield and Yass there is nothing anomalous.

Sub-Order—Zoantharia Perforata.

Group—Cyathophylloidea.

Family—Cyathophyllidæ.

Genus—Cyathophyllum, Goldfuss, 1826.

(Petrefacta Germaniæ, i., p. 54).

Cyathophyllum elegantulum, sp. nov.

(Pl. III., Figs. 5, 6).

Several fragments of an exceedingly elegant astræoid *Cyathophyllum* from Mansfield occur in the collection. This form is made up of corallites about one-eighth of an inch in maximum diameter, and five, six or seven sided, more commonly the latter.

There is no apparent difference in dimensions between the primary and secondary septa. The septa are slightly flexuous, twenty-four in number, and occupy about one-half the corallite, leaving a clear space in the centre, none running to the centre and commingling into a spurious columella as is so frequently the case in other species. The dissepiments occupy about two-thirds of the septate area, the in portion being composed of a row of convex vesicles, against which the tabulæ abut.

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[1] Ann. Rept. Dept. Mines and Agric. N.S. Wales for 1895 [1896], p. 189.

[2] The Hercynian Question. Report of the State Geologist, New York, for 1888 [1889], pp. 408-437.

The central clear space is traversed at regular well-marked intervals by well-developed convex tabulæ, about one-fortieth of an inch apart. The short interseptal loculi are traversed by the dissepiments for almost all their distance.

A well-marked character of this peculiar coral is its distinct biareal disposition as regards the septa. In the Cyathophyllidæ, according to Nicholson[1] (as typified by *Cyathophyllum*) "the septa are numerous, alternately long and short, the longer ones being continued to, or nearly to, the centre of the visceral chamber, where they are usually more or less twisted and give rise to a sort of spurious columella."

The correct generic classification of this form depends wholly upon the view taken of the validity of the non-extension of the septa to the centre of the visceral cavity being a specific rather than a generic character. In the Cyathophyllidæ it is not necessary that the septa should pass to the centre of the corallite, so that there appears to be no difficulty as to its family. The real difficulty is in its generic position—a first glance would suggest *Acervularia* as its resting place, with which it agrees in all points except the important one of the formation of a wall by the thickening of the septa around the inner tabulate area. Also in connection with *Acervularia*, Nicholson says,[2] that "the so-called *Acervulariæ* of the Devonian Rocks are nearly allied to *Cyathophyllum*," while the true *Acervularia* as typified by *A. ananas*, Linn., from the Upper Silurian of Gothland would be more correctly classed under the Astræidæ.

Weissermel has recently established a genus *Storthygophyllum*[3] to take in a coral from the Bordholm beds (Upper Silurian) of Esthland, characterised by alternate straight spine-like septa, free tabulate area, dissepiments vesicular and oblique. The author says: "The new species [*S. megalocystis*] is separated from *Pholidophyllum* and *Polyorophe* by the possession of dissepimental tissue and from all known genera with dissepiments and tabulæ by the rudimentary condition of the septa." In connection with Herr Weissermel's sections, it appears to me hard to reconcile his figures 6 and 7*a* with the descriptions of the one species, as in fig. 7*a* only dissepimental tissue is shown, whereas in the letterpress no mention is made of any part of the corallite being devoid of septa. It appears to me that apart from the difference of the arrangement of the dissepiments, the relative proportion of the central aseptate area and the condition of the tabulæ, most of which points seem to be of specific value only, there is very little difference between the Mansfield coral and *Storthygophyllum megalocystis*, Weiss. If the difference between the Victorian form and some of the described species of astræoid *Cyathophyllum* be considered to be mainly one of degree, the same would hold good for *Storthygophyllum.*

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[1] Manual of Palæontology, 1889, i., p. 286.

[2] *Loc. cit.*, p. 287.

[3] Zeits. Deutsche Geol. Gesell., 1894, xlvi., Heft 3, p. 619, t. 49, f. 6-7*a*.

I have referred to all descriptions of astræoid *Cyathophylla* at my disposal and can find none that approaches closely to this form. *C. bolonensis*, Edw. and Haime,[1] shows that the septa do not extend quite to the centre, though they are much more numerous and the dissepimental area is greater than in our form.

For the meantime I venture to class this form under the heading *Cyathophyllum*, adding to it the specific name of *elegantulum.*

Cyathophyllum mansfieldense, sp. nov.

(Pl. III., Figs. 3, 4).

Several examples of a simple turbinate *Cyathophyllum* occur embedded in limestone from Mansfield.

Septa fifty-two, reaching to the centre and intermingling, alternately long and short, but the difference in length between the two orders is not always very strongly marked, extending to well within the tabulate area. The fossula can only be faintly distinguished.

In the vertical section the dissepimental area is well marked and easily distinguished from the tabulate. The dissepiments occupy about one half the visceral cavity; they are small, vesicular and arranged obliquely downwards. The tabulæ are numerous, incomplete, and vesicular in disposition, those towards the centre of the calice being generally horizontal, whereas those next to the dissepimental area are oblique in arrangement. Primordial septa indistinctly seen in some cases; the septa are slightly thickened by stereoplasma.

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[1] British Pal. Corals, t. 52, f. 1*a*.

I do not think that this form can be confounded with any hitherto recorded from Australian rocks, or with any with which I am acquainted from foreign deposits.

From *C. sweeti*, Eth. fil.,[1] from Reid's Gap, Queensland, it may be readily distinguished by the general appearance of the septa, the less marked counter septum, and the absence of distinct twisting of septa at the centre. There are several undescribed forms from the Upper Silurian of Yass that approach closely to *C. mansfieldense*.

Family—Petraiadæ.

Genus—Petraia, Munster, 1839.

(Beitrage zur Petrefaktenkunde, i., p. 42.)

Petraia, sps. ind.

(Pl. III., Fig. 7, 8).

Under this heading are included some imperfect internal casts of rugose corals from Kilmore and Mansfield. These show the spaces occupied by short septa, longer at the base of the calycinal cup, and almost vanishing towards the mouth, and apparently alternately long and short. There is no trace of tabulate or dissepimental structure.

The genus *Petraia* includes corals characterised by the absence of tabulæ and dissepimental tissue and septa well-marked at the base of the calice, but represented by folds at the top. Some authors do not appear to recognise the validity of this genus, and though doubtless it has been abused, still of late years the general opinion appears to be changing, and some of the leading writers on Palæozoic Actinology give it due rank as a genus—Roemer,[2]

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[1] Procs. Linn. Soc., N. S. Wales, 1895, ix., p. 521, t. 40, f. 3, 4; t. 41, f. 1.

[2] Lethæa Geognostica, 1883, i., Lief. 2., p. 410.

Kunth,[1] Kayser,[2] Lindstrom,[3] Sherzer.[4] By others it has been considered generally as a synonym of *Cyathophyllum.*

Undescribed forms of *Petraia* are of pretty frequent occurrence in the Upper Silurian of the Yass district, New South Wales, which is considered to be of Wenlock age.

The range of this genus is from the Upper Silurian to the Carboniferous.

Order—Monticuliporidea.

Genus—Monticulipora, D'Orb., 1850.

(Prod. Pal., i., p. 25).

Sub-Genus—Monotrypa, Nicholson, 1879.

(Palæozoic Tabulate Corals, p. 320).

Monotrypa, sp. ind.

In the collection there are three specimens preserved in limestone from Mansfield, which, though unsatisfactory, prove the presence of Monticuliporoids in these beds, but the internal structure has been so destroyed by crystallisation that very few details can be made out under the microscope.

The corallites are small and irregular in size, prismatic, usually four, five or six sided, and form a massive and probably globose organism. The cell walls are thin and considerably thickened with sclerenchyma. No trace of mesopores or acanthopores can be seen, neither are monticules present in the specimens as preserved, though in connection with this last point it must be stated that it is doubtful that the true surface of the organism is preserved. The tabulæ are complete, far apart, thin, practically horizontal, and in adjoining tubes almost opposite.

There appears to be no differentiation of the corallites into larger and smaller.

From these few points this form would appear to come closer to Nicholson's *Monotrypa* than any other sub-division of *Monticulipora.* Though agreeing in many points with species recorded by this author[1] and Ulrich,[2] it does not appear to agree specifically with any of the forms described by them. It is to be hoped that more perfect specimens will be available for detailed examination.

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[1] Zeits. deutsche Geol. Gesell., 1870, xxii., p. 37-42.

[2] Abhand. Geol. Specialkarte Preussen, 1878, ii., p. 231.

[3] Bihang K. Sv. Vet. Akad., 1883, viii., 9, p. 12 (separate edition).

[4] American Geologist, 1891, vii., p. 278.

No specimens of Monticuliporoids have hitherto been described from Silurian or Devonian Rocks in Australia, though the genus *Stenopora* is very abundant in the Permo-Carboniferous rocks of New South Wales, Queensland and Tasmania.

The genus occurs in the Lower Silurian-Devonian of North America, and the Lower Devonian of Europe.

PLATE III.

Fig. 1. **Pleurodictyum** (? **megastomum**, McCoy, M.S.) Kilmore.

Fig. 2. **Pleurodictyum.** Mansfield.

Fig. 3. **Cyathophyllum mansfieldense,** Dun. Longitudinal section, x $\frac{3}{2}$. Mansfield.

Fig. 4. **Cyathophyllum mansfieldense.** Transverse section, x $\frac{3}{2}$. Mansfield.

Fig. 5. **Cyathophyllum elegantulum,** Dun. Transverse section, x 2. Mansfield.

Fig. 6. **Cyathophyllum elegantulum.** Longitudinal section, x 2. Mansfield.

Fig. 7. **Petraia,** sp. Kilmore.

Fig. 8. **Petraia,** sp. Mansfield.

Fig. 9. **Favosites gothlandica.** Portion of surface showing corallites. Natural size. Mansfield.

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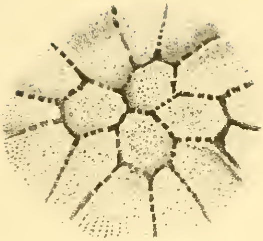
[1] On the Structure and Affinities of the Genus Monticulipora, etc., 1881, pp. 102, 170.

[2] Geol. Survey Minnesota, 1895, iii., pt. i., p. 303.



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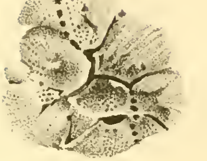

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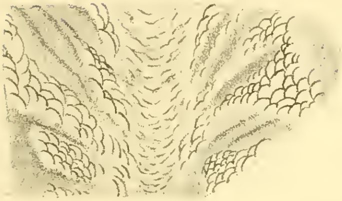

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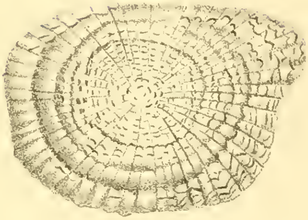

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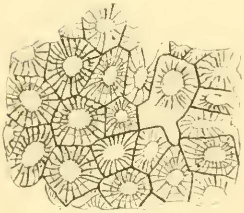

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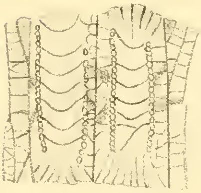

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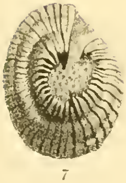

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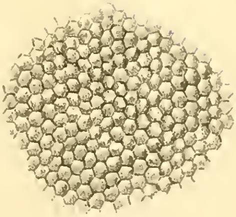

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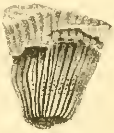

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C.C.Brittlebank del.

R.Wendel Lith.

ART. X.—*On Entropy Meters.*

By E. F. J. LOVE, M.A., F.R.A.S.,

Demonstrator and Assistant Lecturer in Natural Philosophy in the University of Melbourne.

(With Diagram).

[Read 1st July, 1897.]

(1) INTRODUCTORY.

The physical quantity, termed "the Thermodynamic Function" by Rankine, and the "Entropy" by Clausius—a name which has been finally adopted for it by physicists—is first encountered by the student when he is a little way advanced in the study of the dynamical theory of heat, and he generally finds it a stumbling-block. This is scarcely to be wondered at, seeing that no less a genius than Clerk Maxwell succeeded in giving three different —and totally inconsistent—definitions[1] of this conception in successive editions of his "Theory of Heat." Yet it is definite enough; entropy is as definite a property of any portion of matter as is its volume, or temperature, or pressure. When a body receives heat from external sources its entropy is increased, when it gives up heat its entropy is diminished; the change in the entropy being measured by the ratio which the transferred heat bears to the absolute temperature at which the transfer takes place.

Special interest attaches to entropy, inasmuch as it is the only physical property which always increases when heat is supplied, and diminishes when heat is abstracted. A body may receive heat—*e.g.* during fusion or vaporisation—without rising in temperature; cases are even known—*e.g.* saturated steam—such that the entrance of heat is accompanied by a fall in temperature. Similarly we do not always find the volume of a body increased by the entrance of heat; silver iodide contracts when its temperature rises, so does ice during fusion, though both are absorbing heat. But no considerations of this kind come in with regard to entropy; if heat enter the body its entropy rises, if it leave the body its entropy falls; to this rule there are, and can be, no exceptions.

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[1] Two of these, moreover, were hopelessly wrong; the third was correct.

There is no lack, then, of definiteness about this property; the difficulty in grasping its significance is due to its lack of familiarity. We are accustomed to think and speak of volumes and temperatures; probably not one educated man in five could define either accurately, but all are familiar with the terms. The reason for this is, in my opinion, to be found in the fact that instruments for measuring both quantities are in common every-day use; but, so far, we have had no instrument for measuring entropy. The quantity is therefore an unfamiliar one; and the fact that it can easily be calculated from measurements of other quantities helps the student very little in his efforts to gain a clear idea of it.

These considerations—combined with the fact that the instrument, once constructed, would probably be useful—have induced me, for a good many years past, to search for a mode of measuring entropy changes on the scale of a suitable instrument. So far I have not succeeded in constructing a single apparatus which would do this in all possible cases, though I have not yet given up all hope of ultimate success in this direction. The difficulty of the investigation lies in the fact that the change which takes place in the entropy of a body during a transformation is expressed mathematically as the sum of two more or less independent integrals; I do not yet see how an instrument is to be made which will evaluate these simultaneously and add them together.

This difficulty is avoided if we restrict the generality of the apparatus. The restriction is by no means such a disadvantage as it may appear at first sight, seeing that, in the great majority of the transformations we meet with in practice, one or other of the three quantities on which the measurement of the entropy depends is kept constant; only one instrument is then required for observation of the entropy change.

If we design instruments to measure entropy changes at constant pressure, constant volume, and constant temperature, three will be required; one will do the measurements both at constant pressure and constant volume for either solids, liquids, or gases; but two will be required for constant temperature, one for solids and liquids, the other for gases. Moreover, if the two instruments suited to the particular state of matter under consideration be employed together, the algebraic sum of their indications will give the change of entropy during any transformation, whether the pressure, volume, or temperature be changing, or all three change together; provided that no such change of physical state as fusion or condensation occur during the process.

About two years ago I worked out the first rough ideas of the designs for two entropy meters, working models of which are on the table to-night; but the detailed calculations and the construction of the apparatus were only completed lately.

(2) ENTROPY METER FOR CONSTANT PRESSURE OR CONSTANT VOLUME.

The construction of this instrument is based on the following considerations:—

If we denote volume by v, absolute temperature by T, pressure by p, quantity of heat by Q, and entropy by ϕ, the definition of entropy gives us at once

$$\begin{aligned}\left(\frac{\delta v}{\delta \phi}\right)_{\mathrm{p}} &= \mathrm{T}\left(\frac{\delta v}{\delta \mathrm{Q}}\right)_{\mathrm{p}} \\ &= \mathrm{T}\left(\frac{\delta v}{\delta \mathrm{T}}\right)_{\mathrm{p}} \div \left(\frac{\delta \mathrm{Q}}{\delta \mathrm{T}}\right)_{\mathrm{p}} \\ &= \frac{\mathrm{T}}{\mathrm{K_p}}\left(\frac{\delta v}{\delta \mathrm{T}}\right)_{\mathrm{p}}\end{aligned}$$

where $\mathrm{K_p}$ denotes the specific heat at constant pressure

$$\therefore \left(\frac{\delta \phi}{\delta v}\right)_{\mathrm{p}} = \frac{\mathrm{K_p}}{\mathrm{T}} \cdot \left(\frac{\delta \mathrm{T}}{\delta v}\right)_{\mathrm{p}}$$

$$\begin{aligned}\therefore d_{\mathrm{p}}\phi &= \frac{\mathrm{K_p}}{\mathrm{T}} \cdot \left(\frac{d\mathrm{T}}{\delta v}\right)_{\mathrm{p}} \cdot d_{\mathrm{p}}v \\ &= \mathrm{K_p} \cdot \frac{d_{\mathrm{p}}\mathrm{T}}{\mathrm{T}}\end{aligned}$$

Dropping the suffixes and integrating, we have

$$\int_{\phi_1}^{\phi_2} \delta\phi = \int_{\mathrm{T_1}}^{\mathrm{T_2}} \mathrm{K_p} \cdot \frac{d\mathrm{T}}{\mathrm{T}}$$

For most bodies K_p is sufficiently nearly a constant between such temperature limits as 0° and 100°C., and we may replace it in the integral by its mean value; thus we obtain

$$\int_{\phi_1}^{\phi_2} d\phi = K_p \int_{T_1}^{T_2} \frac{dT}{T}$$

$$\text{or } \phi_2 - \phi_1 = K_p.\ \log_e \frac{T_2}{T_1}$$

i.e., the change in the entropy during the transformation is proportional to the difference between the napierian logarithms of the final and initial absolute temperatures.

A perfectly similar calculation shews us that the gain of entropy during a transformation in which the body is kept at constant volume is expressed by

$$\phi_2 - \phi_1 = K_v.\ \log_e \frac{T_2}{T_1}$$

where K_v denotes the specific heat at constant volume. Here again the change in the entropy is proportional to the difference of the logarithms of the absolute temperatures.

We may therefore measure these entropy changes by means of the expansion of mercury. If a mercurial thermometer tube be marked off, not into divisions of equal length, but into lengths proportional to the logarithms of the corresponding temperatures reckoned from absolute zero, its indications will give directly the entropy changes of water, reckoned in thermal units, to about the same order of accuracy as its readings, when it is graduated in the usual way, give absolute temperatures if 273° be added to them. For any other substance the readings must be multiplied by the value of the mean specific heat. In this way the first model on the table (Fig. 1) was constructed; I have merely supplied a thermometer with a scale of napierian logarithms placed opposite to the corresponding temperatures reckoned from absolute zero.

Something more can, however, be done with these instruments than the mere determination of *changes* of entropy. It may frequently be used to measure the entropy of a body from a fixed zero—just as thermometers measure temperatures above and below 0°C.—provided either its pressure or its volume is supposed to remain constant. The zero of the instrument corresponds to a temperature of 1° absolute, or – 272° Centigrade, since at this point the logarithm becomes 0. For temperatures between 1° and 0° (absolute) the readings will be negative, and pass rapidly from 0 to $-\propto^{y}$. It may be objected that entropy is an essentially positive quantity; I would answer, so for that matter is temperature, but no one objects to reckon temperatures negatively below the melting point of ice.

ENTROPY METERS FOR CONSTANT TEMPERATURE.

The principle of these is obtained in the following way:—Employing our old notation, and using in addition the symbol $\hat{\omega}$ to denote the pressure coefficient, and ϵ to denote the isothermal elasticity, we may write the second and fourth thermo-dynamic relations thus:—

$$\left(\frac{\delta\phi}{\delta v}\right)_{\mathrm{T}} = \left(\frac{\delta p}{\delta \mathrm{T}}\right)_{v} = \hat{\omega} p \quad (1)$$

$$-\left(\frac{\delta\phi}{\delta p}\right)_{\mathrm{T}} = \left(\frac{\delta v}{\delta \mathrm{T}}\right)_{p} = a v \quad (2).$$

Dividing (1) by (2), we obtain

$$-\left(\frac{\delta p}{\delta v}\right)_{\mathrm{T}} = \frac{\hat{\omega} p}{a v}$$

$$\text{or } -v\left(\frac{\delta p}{\delta v}\right)_{\mathrm{T}} = \frac{\hat{\omega} p}{a}$$

$$\text{but } -v\left(\frac{\delta p}{\delta v}\right)_{\mathrm{T}} = \epsilon$$

$$\therefore a\epsilon = \hat{\omega} p$$

substitute in (1), we get

$$\left(\frac{\delta\phi}{\delta v}\right)_{\mathrm{T}} = a\,\epsilon$$

$$\therefore d_{\mathrm{T}}\phi = a\,.\,\epsilon\,.\,d_{\mathrm{T}}v. \quad (3).$$

For all substances a is constant so long as the temperature does not vary; ϵ is, under similar circumstances, constant for solids and liquids, but numerically equal to the pressure for a gas.

Dropping the suffixes and integrating, we obtain for a solid or a liquid

$$\phi_2 - \phi_1 = a\,.\,\epsilon\,.\,(v_2 - v_1)$$

Hence an instrument which measures change of volume can measure the entropy changes of solids and liquids. I have not been able to construct a model for this case, as I do not possess a piezometer.

For a gas, equation (3) becomes

$$d\phi = a \,.\, p\, dv.$$

whence (by the gaseous laws) we obtain

$$\phi_2 - \phi_1 = \frac{p_0 v_0}{273} \log_e \frac{p_1}{p_2}$$

Hence entropy change in this case can be measured on a pressure gauge provided with a logarithmic scale, being proportional to the difference of the napierian logarithms of the initial and final pressures.

Here p_0 is one atmosphere, or $1{\cdot}016 \times 10^6$ dynes, and v_0 is the specific volume of the gas under consideration. The latter quantity for air is 773·4 c.m., so $\frac{p_0 v_0}{273} = 2{\cdot}88 \times 10^6$

The difference of the napierian logarithms is independent of the value of the unit of pressure. It is convenient, however, to arrange the zero reading to correspond to a pressure of one atmosphere. Hence, if we graduate our scale so that $2{\cdot}88 \times \log_e p$—where p is estimated in atmospheres—corresponds to the division marked 1, the readings will give directly the entropy changes for air, reckoned in millions of mechanical units; to obtain the same quantity for any other gas we have only to divide the readings by the specific gravity of the gas referred to air.

The model shown (see also Fig. 2), is constructed in accordance with these principles; its graduations will measure entropy changes corresponding to an isothermal variation of pressure between $\frac{1}{40}$th of an atmosphere and 2 atmospheres. It is simply an old pressure gauge—recording between these limits—which has been supplied with a new scale. If the results be required in thermal units, all readings must be divided by 42; the quotients give the entropies, measured from the arbitrary zero of the scale, directly in thermal units.

Had the molecular volume been taken for v_0 instead of the specific volume, the instrument would have been direct-reading for all gases.

Proc. R.S. Victoria, 1897. *Diagram I.*

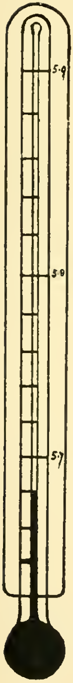


Fig 1.

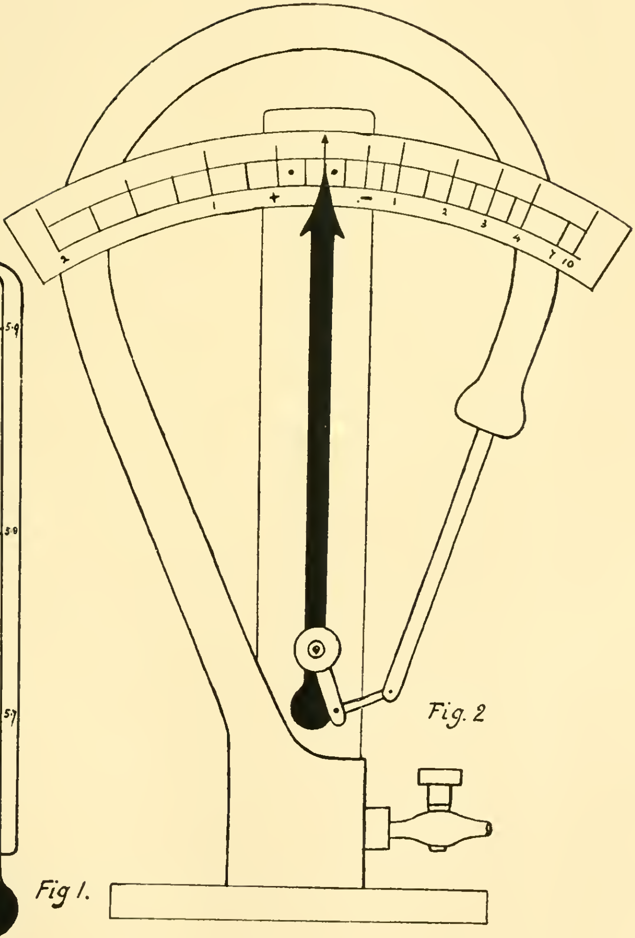


Fig. 2

E. F. J. Love.

Art. XI.—*On a Method of Determining the Specific Heat of a Liquid, especially of Solutions.*

(With Diagram).

By Walter Rosenhain.

[Read 12th August, 1897.]

The subject of the present research was suggested to me in November, 1896, by Professors Lyle and Masson, and my object, in the first place, was to find a convenient and satisfactory method for the accurate determination of the specific heats of liquids; this method it was intended to apply to an extensive series of determinations of the specific heats of solutions, with a view to establishing on an accurate basis the relation between the degree of concentration and the specific heat of a solution. With this object in view, the experimental method was required to comply with a variety of somewhat contradictory conditions. Accuracy being the primary object, the most desirable course seemed to be to follow the lead of Griffith and other recent workers in calorimetry, and make the experiments on a large scale, and to use large masses of the substances to be experimented upon; but, on the other hand, some of the substances to be used were likely to be rare chemicals, and the great expense prohibited the use of large quantities. Further, as such substances as alcohol, ether, chloroform etc., were to be used as solvents, the prevention of evaporation became of importance. Beyond these special conditions applying to the particular purpose in view, the general considerations affecting all calorimetric methods, such as the accurate measurement of the various temperatures involved, prevention or measurement of the loss of heat by radiation, and the efficient stirring of the contents of the calorimeter had all to be carefully regarded.

The first method which was tried depended upon the thermoelectric measurement of a difference of temperature.

The calorimeter was a cylindrical vessel of thin brass, nickel-plated; it hung by a flange packed up with asbestos-paper, inside another similar but larger vessel forming an annular air-space;

the second vessel was similarly hung inside a third vessel, and this finally hung in a cylindrical outer shell of galvanised iron. The whole formed a "nest" of calorimeters very much like a nest of beakers, but each vessel was in contact with the next only along a small flange, and to minimise conduction at these points strips of asbestos-paper were interposed. The calorimeter itself held about 200 grams of water, and the system of air-spaces and polished metal shields protected it very effectively from radiation and convection from the sides and bottom. The top, however, could only be protected by a small, moveable lid to allow of the manipulations. The temperature of the water in the calorimeter was read on a large mercury thermometer divided to one-hundredth of a degree Centigrade. Attached to the outer shield was a small piece of clock-work driving a spindle carrying a small screw-propeller immersed in the calorimeter. The liquid to be experimented upon was enclosed in a small, flat, silver flask, holding about twenty cubic centimetres. The mouth of this flask was closed with a tightly-fitting ebonite stopper; through two suitable holes in this stopper passed a fine copper and german-silver wire respectively; inside the flask these were soldered together and coated with a thin coat of paraffin, thus forming one thermo-electric junction. A second and similar junction was placed in the calorimeter close to the bulb of the large thermometer, and the pair of junctions were connected with a low-resistance reflecting galvanometer showing a spot of light on a scale. The procedure was then as follows—first both calorimeter and silver receptacle were weighed both empty and then with their contents; everything being put in its place, the small silver receptacle was warmed, in an air-bath, to a temperature considerably above that required for the experiment—then it was wrapped in cotton-wool and allowed to cool slowly, the observer keeping it agitated and in the meantime noting the reading of the thermometer in the calorimeter. At the first heating, the spot of light was generally driven completely off the scale, but as the contents of the receptacle cooled the spot re-appeared. As soon as the spot approached to within a few divisions of one particular reading, the stirrer was started, the large thermometer read, and the silver flask taken from its wrappings was brought close to the calorimeter, and at the instant that the spot of light crossed the specified division, the flask was dropped into the calorimeter and the rise of temperature noted on the large thermometer.

Theoretically this is a very simple process and should give very good results, but the difficulties were found to be practically insurmountable. The first difficulty met with was the accurate calibration of the galvanometer scale in terms of degrees centigrade. Thermometer bulb and junction were put into as close a contact as possible, and the temperatures of the vessels in which they were immersed were carefully regulated, and yet no constancy of results could be obtained. The resulting conviction, that thermo-electric junctions are not reliable to an accuracy of one per cent. when used to measure differences of temperature, I find to be shared by a number of those who, like myself, have attempted to use them in this way; but the inaccuracies of this method, as revealed by comparing the results of a number of experiments, were far greater than could be accounted for merely by the variations of the thermal junctions. The explanation seems to lie in a fact which I frequently observed; theoretically the thermometer in the calorimeter should show its maximum indication at the instant that the spot of light on the galvanometer-scale returns to its zero position, for this is supposed to indicate that the two junctions are at the same temperature, and that state once reached there should be no further rise. In practice this was never the case; at times the thermometer reached its maximum before and at others after the galvanometer had returned to zero. This was probably due to one or both of two causes, viz., either a lagging or retardation in the action of the junctions or insufficient agitation and mixing among themselves of the contents of both the calorimeter and the small silver flask. In either case the temperature indicated by the galvanometer is not the mean temperature of the liquid surrounding the junction, and if this is the case when both junctions are inside a well-protected calorimeter in which the temperature-differences are very small, the uncertainty as to the temperature of the contents of the small silver flask at the moment of immersion must be very considerable, as at that instant the outside of the flask is necessarily exposed to the air. Keeping the flask in agitation only confirms these doubts, as it sets up considerable oscillations in the galvanometer, and these oscillations can only be due to a very considerable want of uniformity of temperature in the contents of the receptacle, while in themselves they make it very difficult to decide at what instant a certain deflection of the galvanometer has been reached. Two other causes further increase the risk of error :—in order to admit the silver receptacle, the calorimeter must be opened and this introduces errors due to radiation and convection chiefly from the person of the operator, who must come close up to the apparatus, and also allows of evaporation, and the amount of this evaporation can hardly be determined by re-weighing as the removal of the silver flask would carry away a certain amount of water.

Any one of these objections would in itself have been almost sufficient to justify the rejection of the method, but all of these sources of error had to be carefully avoided when the next method was devised ; and though each is fairly obvious, it required a good deal of experimenting to detect and localise it.

The first step in the attempt to improve the method was in the direction of avoiding temperature-effects due to the proximity of the observer to the apparatus, and the attempt was made to carry out the manipulations by means of rods and pulleys worked from a distance, the thermometers being read by telescope. This succeeded in so far as to avoid the rapid fluctuations in the temperature of the calorimeter just prior to immersing the silver flask, but the difficulties with the thermal junctions still remained. The introduction of a number of junctions into both vessels would perhaps have given a nearer approach to a correct mean difference of temperature, but the conduction of heat along the wires would have introduced a corresponding disadvantage.

Guided by the failures in this direction, a start was then made on rather different lines. The first trials of the new method were made in a very primitive manner, in order to give some idea whether it would be worth while to construct the proper apparatus. A large cylindrical tin vessel of about ten litres capacity had coiled in it several feet of lead-pipe—it was, in fact, the condenser belonging to a still used in the laboratory for distilling water. This formed the calorimeter, and through the pipe was run a stream of warm water so regulated as to flow in at one end at an approximately constant velocity and constant temperature. At both upper and lower end, as close as possible to where the pipe became immersed in the water of the calorimeter, a thermometer was inserted; the temperature of the calorimeter was read by the same thermometer as had been used in the previous method; the same stirrer was also used, but now driven by a water-motor running 300 to 400 revolutions per minute. Everything having been working for some time, the experiment consisted in catching and then weighing the quantity of water running through the lead spiral while the temperature of the calorimeter rose through a given range, say 4°C., the temperature of the in- and out-flowing stream being noted at equal intervals of rise of temperature of the calorimeter, viz., at every tenth of a degree. The results obtained from this rough apparatus were so encouraging that I proceeded to construct a better apparatus. The "nest" of calorimeters was again used, but the innermost one was discarded and the next largest used as the calorimeter; it had a capacity of about 400 to 500 cubic centimetres, and had two metal vessels and two air-spaces as a protection from radiation and convection on sides and bottom; but by the new method the top could be protected also, and this was done by two sheaves of cork about three-eighths of an inch thick and leaving an air-space of about one-eight of an inch between them. In these corks suitable holes were cut to just admit the thermometer, the spindle of the stirrer and the ends of the spiral tube. This latter proved much the most difficult part of the apparatus to obtain. Properly such a spiral tube should be made of silver or platinum with glass ends, but such a thing was not to be obtained in Melbourne, and circumstances did not permit of my delaying the experiments until I could have obtained a spiral from England; consequently I had to fall back on glass tubing as a substitute. My first spiral was made for me by a Melbourne glass-blower, but later on I succeeded in making them myself, though at no small expense of shattered glass. From many points of view, however, glass is not suitable to this purpose, partly on account of its fragility and also because its conducting power is small; but beyond this there seems to be a tendency for the liquid in the calorimeter to stick to the glass far more than it does to metal and so to hinder what is of the greatest importance in a calorimeter—a free and uniform circulation.

On account of the great and obvious convenience for this purpose, another attempt was made to use thermal junctions to measure the difference of temperature between the in- and out-flowing stream. It was impossible to use a delicate thermometer, with its large bulb, in a satisfactory way to measure the temperature of so small a stream of water, and further, the thermal junction could be pushed down the end of the tube just far enough to give the temperature inside the spiral at the very point where it entered or left the surface of the water in the calorimeter. But repeated attempts at accurate calibration only gave in inconsistent results, and the use of thermal junctions and with it of this method of working had to be abandoned for the time being in favour of a method that now suggested itself, in which delicate mercurial thermometers could be used throughout. Nevertheless, I am still inclined to think that the above mode of working, combined with an electrical resistance method of measuring temperatures is likely to give results as good, and possibly better than those actually attained with the method next to be described.

The same calorimeter, glass spiral tube, stirrer, etc., were used for this method, but the experiment consists in simply running into the spiral tube a quantity of hot water sufficient to fill all or nearly all of that part of the tube which is immersed in the liquid of the calorimeter. The liquid whose specific heat it is desired to measure may be used either in the calorimeter—and if 400 cubic centimetres are obtainable this is the more desirable course—or else pure water may be placed in the calorimeter and the experimental liquid may be heated and run into the spiral. In either case an experiment is first made with pure water, and the calculations become very simple.

If θ_1 be the temperature of the hot liquid
θ_0 be the initial temperature of the liquid in the calorimeter
θ be the maximum temperature of the liquid in the calorimeter
w_1 be the weight of the hot liquid run into the spiral
w_0 - - - - - liquid in the calorimeter
and σ_1 and σ_0 their respective specific heats; then, if
W be the water-equivalent of the entire calorimeter and its contents, we have

$$w_1(\theta_1-\theta)\sigma_1 = W(\theta-\theta_0) \qquad - \quad - \quad - \quad - \qquad (i)$$

If water be used in both places and we neglect for the moment the variations in the specific heat of water and assume it to be unity, then

$$w_1(\theta_1-\theta)=W(\theta-\theta_0)$$

$$\text{or } W=\frac{w_1(\theta_1-\theta)}{\theta-\theta_0}.$$

The water-equivalent of the apparatus, exclusive of contents is therefore

$$\frac{w_1(\theta_1-\theta)}{\theta-\theta_0}-w_0=W_1.$$

If the liquid of unknown specific heat σ_0 be now used in the calorimeter, we have

$$\begin{aligned} w_1(\theta_1-\theta) &= (W_1+w_0\sigma_0)\ (\theta-\theta_0) \\ &= W_1(\theta-\theta_0)+w_0\sigma_0(\theta-\theta_0) \end{aligned}$$

$$\therefore \sigma_0=\frac{w_1(\theta_1-\theta)-W_1(\theta-\theta_0)}{w_0(\theta-\theta_0)}$$

If the liquid of unknown specific heat be used in the spiral, we have

$$w_1\sigma_1(\theta_1-\theta)=W(\theta-\theta_0)$$

$$\text{or } \sigma_1=\frac{W(\theta-\theta_0)}{w_1(\theta_1-\theta)}$$

Generally speaking, there will be corrections for the variation in the specific heat of water and also corrections for losses of heat by radiation, but their application is simple and requires no special reference.

I will now proceed to show in detail how each of the quantities involved in the above equations is measured, and also what degree of accuracy is to be attained in each measurement.

θ_1—the temperature of the hot liquid. About twenty to twenty-three grams of the liquid are poured into a glass tube (*a*)—see diagram—enclosed in a large tin vessel (*b*) suitably shaped and containing about twelve litres of water. This vessel is well screened by two felt screens so as to intercept as much as possible of its radiation and especially to screen the calorimeter; the water in it is kept at a temperature of from 50° to 60°C. by means of a very small gas jet beneath it, and its temperature can be kept constant within one-tenth of a degree for hours together. As will be seen from the diagram, the glass tube passes through the water-jacket diagonally, and its upper end projects through a hole in the lid of the tin vessel. This end is closed by a cork, and through a hole in this cork passes the stem of a delicate thermometer graduated to tenths of a degree Centigrade. At its lower end the glass tube contracts to the same bore as that of the glass spiral in the calorimeter and passes out through the rubber stopper (*c*). This stopper is about half an inch thick, and the glass tube ends about half way through it. This end of the glass tube is slipped into the end of a rubber tube, which is left projecting outside for about three inches; a pinch-cock, made of two pieces of wood so as to release very suddenly, grips the rubber tube just as it leaves the stopper—while the liquid is in the hot jacket, this is, of course, closed. The object of this arrangement is to ensure that all the contents of the "hot" tube shall be at the jacket temperature, and the pinch-cock contracting the rather stiff rubber tube up to the point where it is slipped over the glass tube and so holding all the hot liquid well within the jacket. This arrangement is further preferable to a stop-cock on account of the speed and certainty with which it can be manipulated, and this is of importance, as it reduces any loss of heat by radiation during the passage of the liquid along the inch or so of rubber tubing used to connect the tube in the jacket with the spiral tube in the calorimeter at the instant of making the experiment. When it is desired to use as the "hot" liquid any substance such as benzine which would attack the rubber tubing this arrangement could not be used, but a suitable quick-acting glass stop-cock could no doubt be obtained.

The water-jacket being kept warm by means of a gas-jet placed below it, there was a possibility of considerable differences of temperature existing between various parts of the jacket-water, and it was thought that a mechanical stirrer would have to be used, but it was found that with everything in steady work the temperature changes were so very slow and the differences of temperature in various parts of the jacket so inappreciable that stirring was unnecessary; shifting the thermometer bulb from the highest to the lowest portion of the hot liquid in the glass tube produced no visible motion of the mercury, and it was therefore assumed as sufficiently accurate to take the reading of this thermometer as the mean temperature of the hot liquid.

The quantity entering into the result is $\theta_1 - \theta$, and being between 30° and 40°C, an error of ·02°C in the reading of the tenth thermometer would only affect the result to the extent of ·06 per cent.; on the other hand, the quantity $\theta - \theta_0$ is the difference of two readings of the one-hundredth thermometer in the calorimeter, and its value is approximately 2°C. Reading this thermometer with a lens and taking the greatest possible care to avoid any errors from parallax, it is perhaps possible to estimate its readings to ·001°C, but an error of ·001° is very easily made in the reading, and it is very probable that the instrument itself is not really reliable to more than ·005°C, and this really gives a limit to the accuracy which the apparatus can be relied upon to give, of about ·2 per cent. Consequently the arrangements for determining θ_1 were considered to be amply accurate. From the table of specimen results given at the end of this paper it will be seen that sets of results were actually obtained that showed a greater degree of accuracy than that claimed above, but these results are obtained under exceptionably favourable circumstances, and serve rather to show the possibilities of this method when all such causes as tend to accentuate instrumental difficulties, viz., variations of temperature range or masses used, are eliminated, than what can be regularly obtained when such exceptional conditions are not available. As an instance of what is here referred to, one example of such a special circumstance may be mentioned. The large hundredth thermometer used in all these experiments has a range of only 6°C, and is fitted with an arrangement for changing the value of its zero by adding mercury to the column in the stem or by removing some. Now one of the greatest difficulties in the use of such a finely-divided instrument is the "sticking" of the mercury and the consequent motion of the thermometer by "jerks." To avoid errors due to this cause, the water-motor driving the stirrer was so arranged as to keep the thermometer in a slight tremor; this is not a good condition for taking an accurate reading, and the motor had always to be stopped at the instant of taking the reading. This left room for a small amount of sticking, and it was found that at some times this would be very much more marked than at others, depending apparently upon what particular portion of the mercury was in the stem. This alone accounts for the fact that on some days the observations would be in much better agreement than on others. Another source of error, and one which eluded pursuit for some time, was due to allowing any parts of the apparatus inside the calorimeter to be in contact, especially the thermometer bulb and the glass spiral or the wall of the calorimeter; errors due to this cause frequently amounted to 2 or 3 per cent., and it is a little difficult to see why this should be the case. One further reservation must be made—the experiments here described were made with a view of testing the method of working, and all that was desired was a series of mutually agreeing results, the absolute accuracy being of much smaller importance for this purpose. Consequently it was not thought necessary to standardise the thermometers by direct comparison with the air thermometer, but this will have to be done before actual results can be obtained.

With all the above sources of difficulty and error in view, it does not seem too much to say that for very accurate thermal measurements a mercurial thermometer is unsatisfactory, and that the electrical-resistance thermometer will have to be employed, and with it a much greater degree of accuracy, perhaps even to 1 part in 4000 or 5000 may be attained.

The various weights required were very simply determined, but even here the attainment of the greater accuracy was hindered by the fact that the Physical Laboratory of the Melbourne University, where these experiments were carried out, did not possess an accurate balance large enough for the purpose, and the balance used was not only rather heavily strained by the load but was not under favourable conditions for sensitiveness. The only point requiring special reference is the determination of the weight (W_1) of the hot liquid. This is found by weighing the calorimeter and apparatus together with its contents before and after the experiment; the increase of weight was then the weight of hot liquid that had actually entered the glass spiral, free from all assumptions as to how much remained in the tube in the hot jacket or similar uncertainties.

One very important advantage of this method is the ease with which the experiments on any liquid can be repeated under similar conditions, so as to check the experimental work in every way. All that is required is to pump out the contents of the spiral, wash it out with distilled water, pump this out and rinse the spiral with a little spirits and then apply an air-pump for half an hour to thoroughly dry the interior of the spiral. During all this time the contents of the calorimeter are in no way disturbed, the covers and shields are not removed and no evaporation can go on. While the spiral is being dried, the tube in the jacket is re-filled and all will be in a steady condition again by the time the spiral is dry. Then the motor is re-connected, and a few seconds before the experiment is to take place the calorimeter is pushed up to the projecting part of the jacket and the loose end of the rubber tube from the hot tube is slipped over the projecting end of the glass spiral. Then the thermometers are read and the pinch-cock released and in a minute to a minute and a half the thermometer in the calorimeter has reached its maximum.

Some experience of working with the calorimeter as above described showed the necessity of a slight alteration in detail. It was found that in the course of the various manipulations required, but especially in shifting the calorimeter to and from the balance, there was a risk of some of the contents being splashed up against the cover, and a little wet also would occasionally get on the outside cover; as these were made of cork they absorbed the moisture, and the quantity of liquid inside the calorimeter might thus be altered during the course of an experiment without auy indication being shown by the balance. To avoid this, the cork discs were replaced by a piece of solid wood turned to fit and thoroughly varnished so as to be impervious to moisture.

The investigations concerning two further corrections now remain to be described. In the first place the question arose whether the heat generated inside the calorimeter by the action of the stirrer would be sufficient to be perceptible or need the introduction of a correction. To test this matter the calorimeter was set up and the stirrer kept in motion for about one week without interruption and the temperatures of the air in the room and the water in the calorimeter observed at intervals. At first there were considerable irregularites, but after a time the calorimeter began to follow the diurnal variations with a certain amount of diminution of amplitude, but its mean tenperature was not perceptibly higher than that of the room in which it stood; nor was any perceptible difference to be noticed when the observations were continued after the motor had been stopped. No correction for the heat generated by the stirrer has therefore been applied.

The question of applying a correction for the loss of heat by radiation during an experiment was much more important. Originally the usual plan was followed of noting the amount of cooling that occurred in a time, directly after the experiment, of equal length to that required for the experiment itself, and it was found that this amount was, in the summer months, quite imperceptible, the rate of cooling being extremely slow. Recently, however, with a view to increased accuracy that may be expected from the use of an electrical-resistance thermometer, the radiation of this calorimeter was thoroughly tested; the results, embodied in the curves appended to this paper, led to a modification of the apparatus consisting in the introduction of a water-jacket in place of the second air-space.

The "curve of cooling" obtained from the calorimeter in its original state shows that whenever the contents have been freshly heated the cooling is much more rapid at first than it would be under the same external and internal temperatures, if these had been reached by gradual cooling from a higher temperature. The explanation lies in the fact that, after gradual cooling has been going on for some time, the various air-spaces and shields have acquired the temperatures corresponding to steady flow, and it is this steady flow that is observed; on the other hand, when the calorimeter has just been heated all the air-spaces and shields are colder than they would be in the other case, and thus heat leaves the calorimeter to warm up the air and metal, and thus the rate of cooling is very much faster at first than it is when the steady state has been reached. With this arrangement it is therefore a matter of doubt how exactly to determine the radiation correction; during the first part of the experiment the temperature of the calorimeter is rising and the rate of cooling is probably rapid, but on the other hand the difference of temperature is smaller, while later on the difference of temperature is larger but the jackets have had time to become warmed up. In order to avoid this uncertainty in the radiation correction, the second air-space was converted into a water-space containing about 1250 grams of water whose temperature could be read by two thermometers. This made the heat-capacity of the jacket so large that the small amount of heat radiated could not cause any perceptible increase in the temperature of the jacket and consequently in the rate of cooling, and the second curve shows that the rate of cooling, though now much faster than before, is the same whether the contents of the calorimeter have just been heated or whether cooling has been going on for some time.

Throughout these experiments the author has had the great advantage of the personal advice and assistance of Professor T. R. Lyle, in whose laboratory at the Melbourne University the research was carried out; for valuable assistance in the construction of apparatus the author is also indebted to Mr. L. Meyer, the mechanical assistant at the laboratory.

The appended tables of figures from actual experiments will best show the accuracy actually attained, but in addition it may be well to summarise the salient features of the method :—

1. The total absence of evaporation.
2. A calorimeter very efficiently protected and with a very small and very constant radiation loss.
3. Efficient contact between the hot liquid run into the spiral and the cold liquid in the calorimeter.
4. Efficient mechanical stirring and free circulation in the calorimeter.
5. Ease of repeating and checking experimental observations.
6. A degree of accuracy of at least 1 in 500.

I.—EXPERIMENTS WITH PURE WATER IN BOTH SPIRAL AND CALORIMETER.

w_1	$\theta - \theta_0$	θ_1	$\theta_1 - \theta$	W	σ_0(σ_1 assumed = 1).
20·49	1·120°C	48·05°C	30·252°C	553·48 grams	·9967
18·86	0·980°	47·35°	28·580°	550·22 ,,	·9969
21·93	1·089°	47·95°	27·335°	554·49 ,,	·9959
21·61	1·070°	48·10°	27·240°	550·14 ,,	·9955
19·60	0·954°	48·20°	26·885°	552·28 ,,	·9982

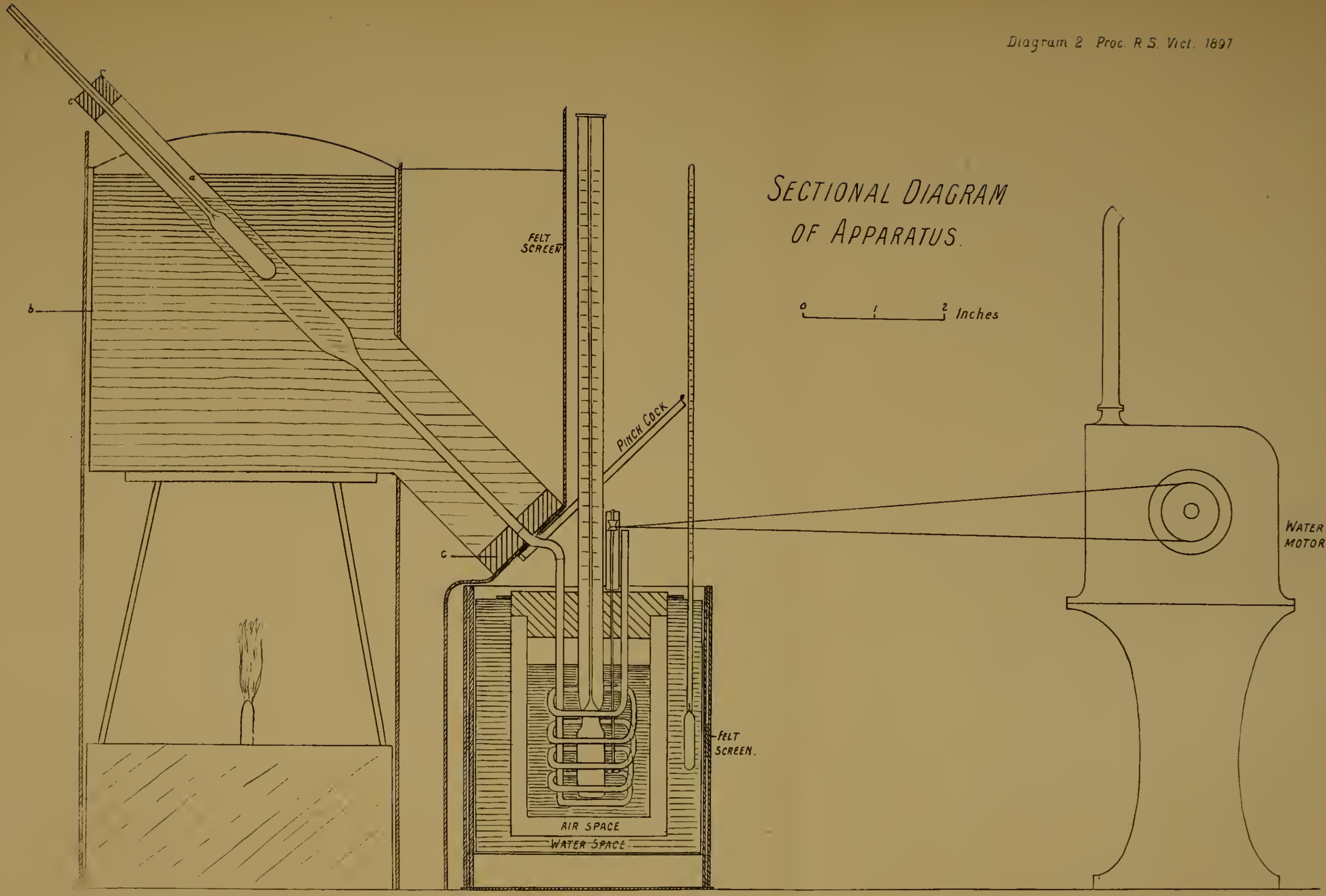
Weight of water in Calorimeter = 497·5 grams.
Mean value of W = 552·12.

II.—EXPERIMENTS WITH A MIXTURE OF METHYL. SPIRITS AND WATER IN CALORIMETER; PURE WATER IN SPIRAL.

No. of Experiment.	w_1	$\theta - \theta_0$	θ_1	$\theta_1 - \theta$	W	σ_0(σ_1 assumed = 1).
1	22·07	1·925°C	46·80°C	26·645°C	*305·48	·7541
2	21·14	1·940°C	49·50°	28·050°	305·66	·7546
3	21·95	2·110°	50·00°	29·195°	303·71	·7531
4	21·69	2·125°	50·90°	29·675°	302·89	·7516

* Weight of liquid in Calorimeter for 1 and 2 was 549·64 grams; weight of liquid in Calorimeter for 3 and 4 was 547·91 grams.

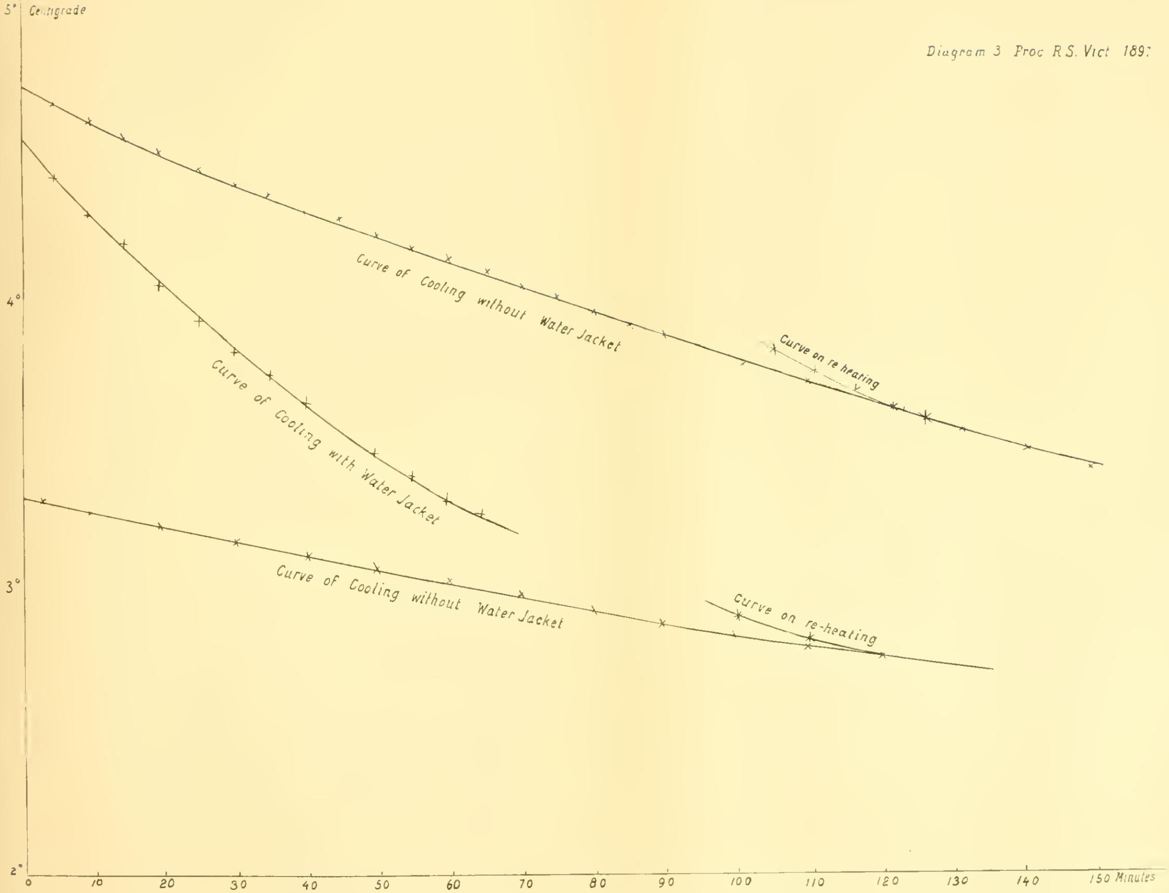
Diagram 2 Proc. R S. Vict. 1897



SECTIONAL DIAGRAM OF APPARATUS.

Rosenhain delt.

Diagram 3 Proc R.S. Vict 1897



Rosenhain delt.

III.—Experiments similar to those in Table I.

w_1	$\theta - \theta_0$	θ_1	$\theta_1 - \theta$	W	$\sigma_0 (\sigma_1 = 1)$.
19·21	1·980°	59·80°	45·41°	440·5	·9976
19·49	1·955°	59·90°	44·10°	439·6	·9977
20·51	2·110°	60·45°	45·19°	439·2	·9979
21·01	2·200°	61·25°	45·70°	440·9	·9987

IV.—Experiments with Sugar Solution containing five-tenth-gram-molecules of Sugar per litre.

w_1	$\theta - \theta_0$	θ_1	$\theta_1 - \theta_0$	W	$\sigma_0 (\sigma_1 = 1)$.
20·88	2·310°	62·70°	46·98°	428·8	·8902
19·48	2·318°	66·90°	51·11°	429·5	·8929
20·01	1·740°	54·60°	37·31°	429·3	·8923

ART. XII.—*Description of a New Species of Unio from the River Glenelg.*

By J. DENNANT, F.G.S.

[Read 12th August, 1897.]

(Plate IV.).

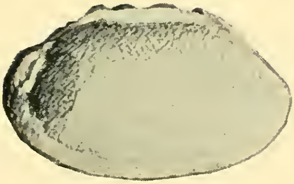
About twelve years ago I picked up on the banks of the Glenelg at Dartmoor a few worn valves of a *Unio* markedly differing in outline from the well-known *U. australis*, which is abundant in that stream as well as in most others of the colony. No other specimens were met with from that time till the Christmas Vacation of 1895, when a holiday trip took me to Roseneath, many miles higher up the same river. Several examples were there gathered, but all as dead shells, and though the friend whom I was visiting dived and searched the mud at the bottom of the river for living ones, he was unable to find any. He has, however, since sent me a young one which has a perfectly fresh appearance. Examples of the shell have also been forwarded to me by the Rev. W. Whan, but they are from the same locality, viz., Roseneath.

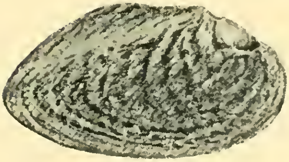
This *Unio* possesses characteristic features which distinguish it from all other Australian species known to me, either by actual examples or from published plates and descriptions. I take this opportunity of acknowledging my great indebtedness to Dr. James Cox of Sydney, who has kindly furnished me with a fine collection of the Unios of New South Wales.

The following is the diagnosis of the species:—

Unio glenelgensis, spec. nov.

Shell ovately sub-rhomboidal, sub-depressed, inequilateral, lengthened posteriorly; anterior side short and together with the ventral edge regularly curved; posterior dorsal margin straight along hinge line, and then sharply sloping downwards by a slightly sinuous line to the roundly pointed posterior end;





J. Dennant.

posterior dorsal keel steep, broad, triangular, conspicuous externally, and visible internally. Umbones prominent, deeply eroded in adult shells.

Surface rough with two series of markings, one consisting of undulating concentric ridges, a few of which are coarsely crenulated, and the other of five or six rows of irregular, prominent, nodose wrinkles angularly arranged around the umbo and with deeply-cut interspaces. The latter series of markings is oblique to the former and constitutes a characteristic rib-like ornament.

Epidermis thick, brown to brownish black. Internal surface smooth in adult shells, nacre bluish to light brown, not brilliant.

Cardinal teeth faintly indicated, anterior in left and lower anterior in right frilled, and with a deep pit beneath them in both valves.

Length 40, breadth 23, thickness through both valves 13·5 millimetres.

The species is allied to *U. depressus* by its dentition, but differs from that shell in shape as well as in other important features. *U. nepeanensis* shews a few wrinkles on the umbonal region, but as far as I can judge by the single example in my collection its surface is otherwise comparatively smooth, while in general outline it resembles young examples of *U. australis.*

ART. XIII.—*Observations on Muridæ from Central Australia.*

By EDGAR R. WAITE, F.L.S.,

Zoologist, Australian Museum, Sydney.

(Communicated by Professor BALDWIN SPENCER, M.A.)

[Read 21st October, 1897.]

(Plates V. and VI.)

Since the publication of the *Muridæ* of the Horn Expedition[1] Prof. Baldwin Spencer of Melbourne has obtained from Messrs. P. M. Byrne, F. J. Gillen, and C. E. Cowle a number of additional specimens from Central Australia. As on the former occasion these have been submitted to me for examination, and prove to be of considerable interest.

The collection does not contain any species new to science, but has furnished material whereon I have found it necessary to establish two new genera. One of these, it is believed, will include the typical jumping forms, the other is to receive a known species possessing a peculiarity previously overlooked. This is the presence of an external throat pouch, particulars of which are discussed later.

It has been necessary to redesignate one species, on account of the preoccupation of the name in general use. In this case, as well as in most of the species enumerated, the opportunity has been embraced of describing the cranial and other neglected features. The specimens are preserved in spirits and the measurements, in millemetres, are taken with a vernier scale, which, especially in the cranial dimensions, gives an accuracy scarcely obtainable with the rule and compass.

An examination of *Hapalotis longicaudatus* reveals the fact that the hind feet differ greatly from those of the typical *Mus*, not only in their relative increased length, but also in the number and arrangement of the foot pads. Hitherto this species has been included in *Conilurus*, Ogil., of which the type is *C. conditor*, but a reference to the type species shows that it has not the peculiarity here sought to be emphasised; it would therefore appear that there is no alternative but to create a new genus for the species in question. How many more of the species now ranked under *Conilurus* will be required to follow *C. longicaudatus* into the new genus, is not yet decided, but *C. apicalis* and *C. pedunculatus* will certainly not do so.

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[1] Report Horn Exped., 1896, ii., pp. 393., *et seq.*

Conilurus apicalis. Fig. 1.

Hapalotis apicalis. Gould, Proc. Zool. Soc., 1851, p. 126.
Mamm. Aust., III., pl. 2.
Spencer, Report Horn Exped., II., p. 11.

Gould's figure is an excellent representation of this animal and there is little to add to the color-description; the brown on the tail is confined to the basal half of the upper surface, and the hairs towards the tip are considerably lengthened, forming a pencil of white. Gould described the tail as being thinly clothed, but it is probable that the tail of his single example had been somewhat denuded of hair. The mark on the fore feet mentioned and illustrated is exhibited by our specimen, the hind feet also show a dark mark. The fur of the under parts is white at the base, that of the coloured portions dark grey. The hind limbs are not specially lengthened, and I would therefore consider that the method of progression was rat- and not jerboa-like.

Tail-scales average nine to the centimetre. Mammæ, $0 \cdot 2 = 4$.

Skull somewhat elongate without marked ridges, preorbital processes large; anterior palatina foramina wide, front edge of anterior zygoma root quite straight and perpendicular, upper angle gently rounded; coronoid feebly developed and the incisor capsule very low, scarcely raised in fact.

This incisor capsule necessarily absent in so many types, yet forming such a conspicuous feature in the mandible of Myomorphic and other Rodents, is subject to considerable variation, but whether it is a character worthy of special note I cannot yet say: the descriptive term is adopted from Merriam's[1] Pocket Gophers.

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[1] Merriam. Monograph of Geomyidæ, 1895, fig. 49. *ic.*

Its small size in the present species leads me to direct attention more particularly to it. Covering the root of the long and curved incisor, it is to be found on the outer side of the mandible approaching the sigmoid notch. It may be very prominent and reach quite to the notch as in *P. longicaudatus* (see I.c. fig. 2.a.) or so low as to scarcely protrude above the general level as in *C. apicalis* (fig. I.a.).

Teeth. Incisors rather slight, molars of dark horn color of ordinary type, but attention may be drawn to the pattern assumed by the wearing down of the third molar.

DIMENSIONS.

Head and body	169·0
Tail	236·0
Length of head	48·4
Muzzle to ear	38·5
Ear	31·0
Forearm and hand	44·0
Hind foot	40·8
Heel to front of last foot pad	21·4
Last foot pad	5·0

SKULL.

Greatest length	41·4
Basal length	35·3
Greatest breadth	20·7
Nasals, length	14·6
Nasals, greatest breadth	4·7
Interorbital breadth	5·2
Interparietal length	5·6
Interparietal breadth	8·8
Brain-case, breadth	16·9
Anterior zygoma root	4·8
Diastema	10·6
Palate, length	21·4
Anterior palatina foramina	7·5
Upper molars, length	7·4
Lower molars, length	7·7
Condyle to incisor tip	27·3
Coronoid tip to angle	11·5

Habitat. Alice Springs, Central Australia.

Conilurus pedunculatus.

Waite. Report Horn Exped., 1896, II., p. 395, pl. 25, fig. 1.

The collection includes several examples of this peculiar species, not differing from the typical ones previously described. A greater proportion, have however, the tail perfect ; a certain number have, as before, suffered fracture, and in one case union had taken place with the fractured portion twisted out of its proper direction.

A fair series has previously been measured and the information thus obtained need not be augmented, but it may be advisable to compare the dimensions of the head and body with those of the tail, for the imperfect condition of the majority previously received precluded the possibility of an adequate comparison.

DIMENSIONS.

	♂	♂	♂	♀
Head and body - - -	118	117	115	92
Tail - - - - -	121	120	122	97

These specimens are from Alice Springs, Central Australia, whence also the types were obtained.

PODANOMALUS, gen. nov.

General characters, murine. Hind limbs lengthened, the hind foot long, with a diminished number of pads, some of which may be very small.

Podanomalus longicaudatus. Fig. 2.

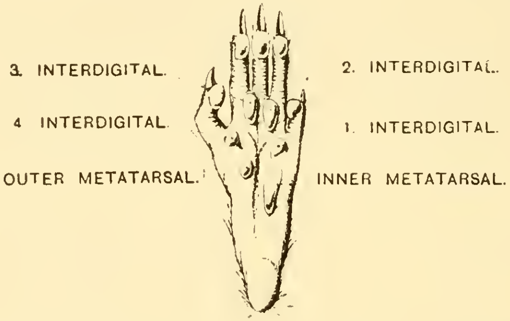
Hapalotis longicaudatus. Gould, P. Z. S., 1844, p. 104.

Hapalotis mitchelli, Spencer (as of Ogilby). Report Horn Exped. II., p. 10.

Mamm. Aust., iii., pl. 8.

This species is represented by several examples which agree in all important particulars with the description and figure as rendered by Gould. The white hairs of the tail, when present, appear to be developed chiefly on the lower surface, and in none of the specimens collected are they so numerous as to produce the white tip mentioned by this writer.

The hind feet, which present the greatest peculiarity of the animal, are remarkable for their length and for the small number of the pads. In order to fully appreciate the peculiarity, the feet of *Mus decumanus* may be first examined. This species is much more suitable for a type than *Mus rattus*, (sometimes adopted), because it is everywhere procurable, whereas the latter species is not only troublesome to obtain, but its identification may present subject for controversy.



Right hind foot of Brown Rat *(Mus decumanus)*, showing number and position of foot pads. (Natural size).

The sole of the foot of the Brown Rat is furnished with six pads, one at the base of each interdigital fissure, (the first, second, third and fourth interdigitals), the fifth, posterior to the pad at the base of the outer digit (outer metatarsal), and the sixth on the inner side, nearest to the heel (inner metatarsal). This last pad is narrow and long, but in some species it is quite small and roundish, and as it is a valuable factor, its relative size and distance from the heel is made use of for descriptive purposes.

Turning now to the foot of *Podanomalus longicaudatus* (fig. 2.e.) it will be observed that of the usual six pads, two or more are absent. The metatarsals are quite obsolete, and it is only in certain examples that the first interdigital may be traced.

A comparative study of the pads, the toes, and of the greatly lengthened limb, shows very conclusively that the rat progresses by leaps like a kangaroo or jerboa; while similar comparisons in the case of *Conilurus* equally convince me that these advanced in the more usual manner.

In addition to the peculiarities already mentioned, the foot is very narrow, and the first and fifth digits are set back, so that instead of the first digit reaching almost to the front of the anterior pads, and the fifth far beyond them, as in *Mus decumanus* they altogether fail to approach them or barely reach their posterior edge respectively.

The various characters here sketched suggest a tempting field of speculation on the evolution of the foot, which however will be here, merely indicated. The practice of jumping, necessarily throws the area of contact with the ground very far forward; the first and fifth digit are unnecessary for such progression, as abundantly proved by the consideration of other forms, such as *Alactaga*, *Euchoretes* and *Platycercomys.* These digits become reduced to mere vestiges, indicating a former function and finally disappear as in *Dipus.* That such a condition is taking place in *Podanomalus* is suggested by the recedence and shortening of these digits, and more especially by the absence of their pads, which, being tegumentary structures, would naturally become lost long before the bones themselves suffered material diminution.

The phraseology used is strictly conventional; the same appearance would be produced by the advance of the median digits as by the retreat of the external ones. It is extremely probable that both factors are operative in bringing about the result.

Tail-scales average twelve to the centimetre. Mammæ, 0·2 = 4. Palate ridges, three predental and six interdental.

Skull. Stout, smooth, facial portion rather produced, preorbital processes well developed: bullæ large, the portion above the meatus projects considerably and can be seen when viewed from above: front edge of anterior zygoma root evenly concave, the upper portion projects and forms a sharp angle. The interparietal is very narrow, being only half the width of the brain-case: coronoid low, not projecting above a line drawn from the tip of the incisor to the top of the condyle; the angle is deflected outwards and deeply excavated to receive the masseter: foramen magnum much higher than wide.

Teeth. All the teeth with the exception of the last lamina of the third molar are visible when viewed from the outer surface in profile. In all the *Mus* I remember to have examined, the third molar, and frequently a large portion of the second, is hidden by the front edge of the ascending ramus.

The molar ridges appear to be rather simple, the outer tubercule is ill developed while the inner one of M^1 is bent backwards and set somewhat behind the lamina, its longer axis is anterio-posterior. The teeth of the specimens examined are abraided so that the condition cannot be wholly ascertained.

There is some difference in the size of the adult specimens measured, but the general color, form, and cranial characters do not present features of specific import.

In reference to the following scale of dimensions, attention is drawn to the fact that the measurement "Heel to front of fourth foot pad" is not comparable with "Heel to front of last foot pad" (the inner metatarsal) as rendered in all species excepting this and the one next described. It may be further explained that the word "fourth" refers to the position rather than to the number, for examples may be examined which have three pads only, the first interdigital being absent: a reference to the diagram on page 118 will render the description easier to follow.

Also, in cases, as in the present species, where the pad measured is very small, the size of that of one individual alone has been given, for no benefit could accrue from elaborating such an approximate dimension as this one must necessarily be.

DIMENSIONS.

	A ♂	B ♂	C ♂	D ♀	E ♀
Head and body - -	131·0	125·2	118·0	124·0	119·0
Tail - - - - -	192·0	187·0	157·0	192·0	156·0
Length of head - -	43·0	42·3	41·4	40·8	37·4
Muzzle to ear - -	36·4	36·1	35·6	35·0	31·6
Ear - - - - - -	26·4	24·5	26·8	24·0	21·9
Forearm and hand -	34·2	34·3	34·0	34·1	32·7
Knee to heel - -	56·8	53·5	54·2	52·0	46·8
Hind foot - - -	44·1	42·9	43·0	42·0	42·0
Heel to front of fourth foot pad	26·2	24·4	24·0	24·3	24·4
Fourth foot pad - -	1·3	...	...	...	...

SKULL.

	C ♂	E ♀
Greatest length	39·9	35·2
Basal length	33·2	28·3
Greatest breadth	21·8	19·0
Nasals, length	14·9	13·2
Nasals, greatest breadth	4·5	3·5
Interorbital breadth	6·3	6·4
Interparietal length	4·6	4·6
Interparietal breadth	9·2	9·4
Brain-case, breadth	18·1	18·0
Anterior zygoma root	5·0	3·6
Diastema	10·4	8·6
Palate length	20·6	17·3
Anterior palatina foramina	8·2	6·4
Upper molars, length	6·8	6·3
Lower molars, length	6·4	6·4
Condyle to incisor tip	26·0	22·3
Coronoid tip to angle	10·5	8·8

Habitat. Urwaitcha burrows, Burt Plains, north of Alice Springs, Central Australia.

Obs. Professor Spencer, in his report of the Mammalia of the Horn Expedition, recorded three rodents from Central Australia, of which two, *Hapalotis apicalis* and *H. cervinus*, are identified with species herein determined. As it seemed probable that his third species, *H. mitchelli*, might be identical with the one above considered I forwarded specimens for his opinion. My friend kindly wrote as follows:—"Undoubtedly what I called, after long doubt, *H. mitchelli* is your *P. longicaudatus*." The former species is, therefore, not to be included in the fauna of Central Australia, and the remarks printed on page 10 of the report, together with the native name of Ulabaiya are applicable to the latter species only.

THYLACOMYS, gen. nov.

General characters, murine, differs from *Podanomalus* mainly by the development of an external pouch on the lower part of the throat.

Thylacomys cervinus. Fig. 3.

Hapalotis cervinus. Gould, Proc. Zool. Soc., 1851. p. 127.
Mamm. Aust., III., pl. 10.
Spencer, Report Horn Exped., II., p. 11.

To the coloration of typical examples as rendered by Gould, there is little to add. The fur of the under surface is white throughout, that of the upper parts is grey at the base. The tail at the proximal half is scantily clothed; the distal portion is pencilled as shown in the figure,—a feature not referred to in the text.

Tail scales average fifteen to the centimetre. Mammæ, 0·2 = 4.

A darker form was considered to be a second species of the genus until a comparative examination of the skulls showed it to be specifically identical. The fawn colored portions are replaced by a much deeper tint and the fur of the under parts is grey at the base. This variety is perhaps the one referred to by Gould as "sometimes met with," but his figure (in the background) does not represent our specimens very accurately. In color it resembles *C. mitchelli*, but may be readily distinguished by its smaller size and peculiar long ears, so characteristic of the species. With regard to *C. mitchelli*, I have not specimens available for examination but suspect that its features will ally it with *Podanomalus* rather than with *Conilurus.*

The Pouch, the peculiarity of the genus, is situated on the lower part of the throat somewhat in advance of the fore limbs. It is a rather shallow depression lined with fine hair, the lower border is thickened and of ⏟ shape. At present the object of the pouch can only be conjectured, but it is to be hoped that when its presence has been made known to the gentlemen who are so successfully collecting the specimens in Central Australia, special observations may be made. It can be confidently assumed that the pouch is in no way analagous to that of a Marsupial, and one may suggest that it is used, as in the *Geomyidæ*, for storing food. These little animals may have some distance to travel in the desert for their dinners and possibly carry their suppers home with them. In the contracted state as observed in preserved specimens the pouch seems somewhat small for the purpose, but in the living animal it may be capable of considerable distension.

Apart from their smaller size the hind feet are very similar to those of *P. longicaudatus* already described: the main difference is in the longer fifth toe, which reaches to about the centre of the anterior pad.

Skull. Smooth, without ridges, frontal portion slight and straight above in profile: the zygomatic arches are bent inwards in the centre, producing the appearance shown in the figure: the anterior zygoma root is projected forward above, leaving the front edge deeply concave: coronoid weak.

Teeth. In the molar series the inner tubercles are behind the general level of the lamina and the longer axis is agreeable with that of the tooth, in both respects resembling *Podanomalus longicaudatus.*

Habitat. Charlotte Waters and Alice Springs, Central Australia.

DIMENSIONS.

	Typical Race.			Dark Race.		
	A ♂	B ♀	C ♀	D ♂	E ♂	F ♀
Head and body -	100·0	107·0	97·0	94·9	91·0	109·4
Tail - - - -	127·8	129·5	116·0	128·3	118·0	137·7
Length of head -	33·7	34·3	30·8	33·5	32·3	33·4
Muzzle to ear - -	27·7	28·5	24·7	28·2	25·9	27·6
Ear - - - - -	25·3	24·4	21·8	26·5	21·6	22·7
Forearm and hand -	24·6	25·2	24·2	24·7	25·9	25·8
Knee to heel - -	40·7	40·9	37·4	44·1	36·5	38·4
Hind foot - -	33·3	32·8	31·9	35·8	31·8	32·3
Heel to front of fourth foot pad -	...	...	18·7	...	17 9	...

SKULL.

	Typical Race.		Dark Race.	
	A ♂	C ♀	D ♂	E ♂
Greatest length - - - -	30·5	29·1	30·7	29·6
Basal length - - - - -	24·8	23·7	25·5	24·2
Greatest breadth - - - -	15·1	15·2	16·0	16·0
Nasals, length - - - -	9·6	9·4	10·4	10·3
Nasals, greatest breadth -	2·7	2·7	2·9	2·8

	Typical Race.		Dark Race.	
	A ♂	C ♀	D ♂	E ♂
Interorbital breadth	5·7	5·4	5·5	5·3
Interparietal length	3·8	3·8	3·3	3·2
Interparietal breadth	8·3	8·4	6·9	7·0
Brain-case, breadth	14·6	14·5	14·8	14·6
Anterior zygoma root	3·0	2·8	3·0	3·1
Diastema	8·5	7·0	7·3	7·3
Palate, length	15·3	14·4	15·3	15·3
Anterior palatina foramina	4·6	4·9	4·6	5·0
Upper molars, length	5·0	5·0	4·8	4·9
Lower molars, length	4·7	5·2	4·9	4·7
Condyle to incisor tip	19·5	18·9	19·1	18.3
Coronoid tip to angle	8·1	7·6	7·4	7·3

Mus greyi.

Gray. Grey's Trav. Austr., App. II., p. 410.

Collett. Zool. Jahrb. II., 1886-7, p. 837.

Waite. Report Horn Exped., II., p. 401, pls. 25 and 26, fig. 3.

The members of the Horn Expedition secured three examples of this species, all males; an individual since obtained being a female, shows that the number and position of the mammæ is 2·3=10, particulars of which were not previously known.

Locality. Tennant's Creek.

DIMENSIONS.

	♀
Head and body	129·0
Tail	131·0
Length of head	38·9
Muzzle to ear	30·6
Ear	16·7
Forearm and hand	33·6
Hind foot	26·0
Heel to front of last foot pad	13·8
Last foot pad	3·9

SKULL.

Greatest length	? 36·5
Basal length	? 31·0
Greatest breadth	20·8
Nasals, length	12·2
Nasals, greatest breadth	3·8
Interorbital breadth	5·0
Interparietal length	4·9
Interparietal breadth	9·7
Brain-case, breadth	? 16·0
Anterior zygoma root	4·6
Diastema	10·8
Palate, length	19·8
Anterior palatina foramina	6·9
Upper molars, length	7·1
Lower molars, length	7·0
Condyle to incisor tip	25·9
Coronoid tip to angle	13·0

Mus villosissimus, nom. nov.

Mus longipilis. Gould, Mamm. Aust., III., 1863, pl. 13.
Not Waterhouse, Proc. Zool. Soc., 1837, p. 16.

It is gratifying to find that this rat has again been obtained; the type, preserved in the Australian Museum, is somewhat faded; advantage has therefore been taken of fresh examples, wherefrom to supplement the original description.

In consequence of the preoccupation of the original name as above indicated, it has been necessary to redesignate the species; and in selecting the name, *Mus villosissimus*, I have endeavoured to preserve the reference to the most striking feature presented by the species.

Fur, long, close, harsh, generally of a sandy color but apparently darker owing to the numerous black hairs which are mostly just tipped with white: the color at the base of the upper hairs is dark grey, that of the lower surface somewhat lighter. The feet are white haired, the tail is not so long as the head and body together, and the hairs are short, black and stiff: scales average ten to the centimetre. Mammæ, 2·3 = 10. Two examples have been received, one of each sex.

Skull. Very similar to that of *Mus decumanus* and an illustration of the one might almost do duty for the other, indeed, were it not for the striking external features one would almost feel inclined to regard the two as identical. The main cranial differences as shown by my specimens respectively are as follows:—In *M. villosissimus* the foramen magnum is ∧ shaped above and is deeper or as deep as wide; the profile of the skull exhibits a greater arch and the nasal portion is more bent down, the interorbital breadth is somewhat less and the anterior palatina foramina are very long and narrow, extending to nearly between the centres of the first molars.

Teeth. The molar series are set closer together than in *M. decumanus*, but as both the skulls of M. villosissimus are of aged examples the teeth are worn down and much of their character obliterated.

DIMENSIONS.

	A ♂	B ♀
Head and body - - - -	153·0	163·0
Tail - - - - - -	144·0	147·5
Length of head - - - -	45·7	46·1
Muzzle to ear - - - -	33·4	36·0
Ear - - - - - -	20·2	20·5
Forearm and hand - - -	42·8	38·9
Hind foot - - - - -	34·0	30·6
Heel to front of last foot pad -	16·6	15·0
Last foot pad - - - -	5·9	4·8

SKULL.

	A ♂	B ♀
Greatest length - - - -	42·5	41·1
Basal length - - - -	37·8	37·5
Greatest breadth - - - -	...	20·0
Nasals, length - - - -	15·9	15·0
Nasals, greatest breadth - -	4·0	4·2
Interorbital breadth - - -	5·7	5·2
Interparietal length - -	4·5	4·8
Interparietal breadth - - -	10·4	10·6
Brain-case, breadth - -	15·4	15·2
Anterior zygoma root - -	5·1	4·8

	A ♂	B ♀
Diastema	11·9	12·0
Palate, length	22·9	22·3
Anterior palatina foramina	8·4	8·5
Upper molars, length	8·2	7·8
Lower molars, length	7·9	6·9
Condyle to incisor tip	...	27·8
Coronoid tip to angle	14·8	14·2

Mus nanus. Fig. 4.

Gould. Proc. Zool. Soc., 1857, p. 242.

Mamm. Austr., III., pl. 20.

The following notes are drawn up from five specimens identified without difficulty. Gould's figure of this species is, I should say, unmistakeable, and but little can be added to the description of the external features. The fur is chestnut intermixed with black hairs, and the general character is very harsh. On the fore legs is a dark mark, mainly on the outer side, the ears are short, sparsely clothed with hairs: the tail is a little shorter than the head and body: the scales average fifteen to the centimetre. Mammæ, 0·2 = 4.

Skull. Arched, nasals bent downwards, converging to an acute angle behind: anterior zygoma root slightly emarginate; interparietal very wide, extending well across the brain-case. In the mandible the angle is conspicuously rounded.

Teeth. Upper incisors strongly curved: the molar series diverge in a marked manner.

Dimensions.

	A ♂	B ♂	C ♀	D ♀
Head and body	85·0	80·0	96·0	76·4
Tail	82·0	90·0	94·5	86·0
Length of head	29·9	28·7	30·2	27·5
Muzzle to ear	25·0	24·1	24·5	22·7
Ear	11·2	10·5	11·6	10·2
Forearm and hand	23·7	23·6	24·8	21·9
Hind foot	21·0	20·4	21·7	20·5
Heel to front of last foot pad	10·4	10·1	10·4	9·3
Last foot pad	1·9	...	...	...

SKULL.

	♀
Greatest length	26·2
Basal length	22·6
Greatest breadth	14·3
Nasals, length	9·3
Nasals, greatest breadth	3·0
Interorbital breadth	3·7
Interparietal length	4·1
Interparietal breadth	9·6
Brain-case, breadth	12·8
Anterior zygoma root	3·2
Diastema	6·5
Palate, length	14·0
Anterior palatina foramina	3·9
Upper molars, length	5·2
Lower molars, length	4·9
Condyle to incisor tip	17·4
Coronoid tip to angle	8·8

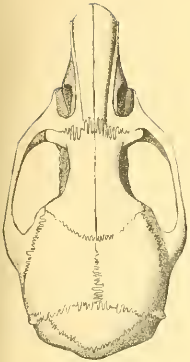
Habitat. Specimens marked A and B are from Porcupine Sandhills, Wycliffe Creek; C from Barrow Creek; and D from Untaünua, Porcupine Grass, Alice Springs, Central Australia.

Obs. Some immature specimens from Alice Springs I referred to the genus Mastacomys. Having since examined further material, including fossil teeth from the Wellington Caves, I now consider the Central Australian specimens to be very young examples of *Mus nanus.*

EXPLANATION OF PLATES.

Fig. 1. Conilurus apicalis, Gould. Skull × 1½.
,, 2. Podanomalus longicaudatus, Gould. Skull × 1½.
,, 3. Thylacomys cervinus, Gould. Skull × 2.
,, 4. Mus nanus, Gould. Skull × 2.

a, skull in profile; *b*, ditto from above; *c*, ditto from below; *d*, upper molars; *e*, hind foot; *f*, pouch.



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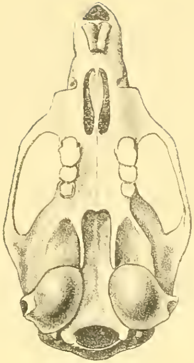

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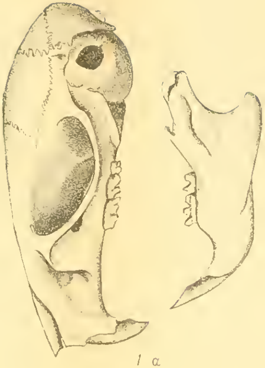

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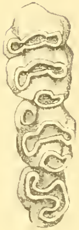

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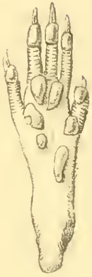

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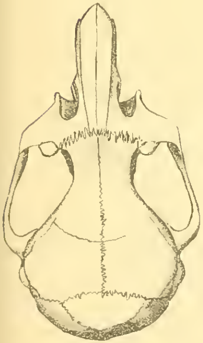

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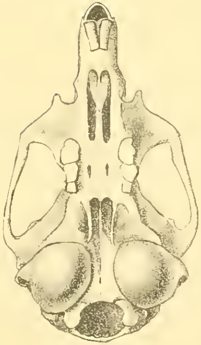

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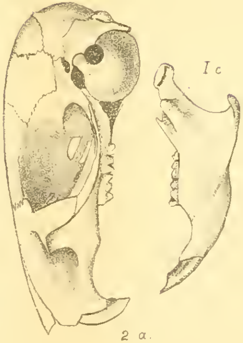

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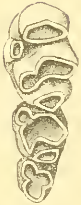

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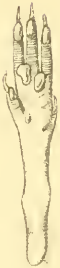

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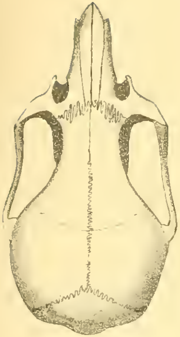

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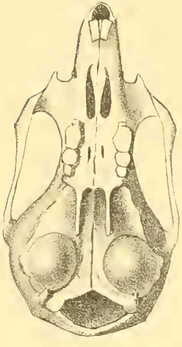

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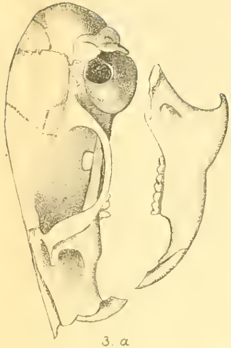

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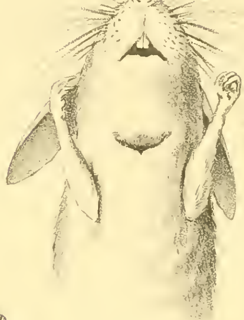

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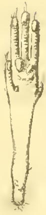

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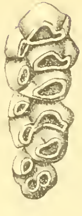

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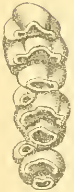

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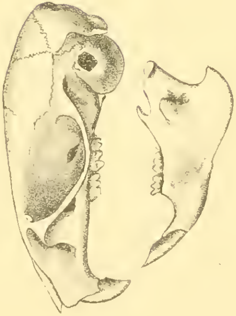

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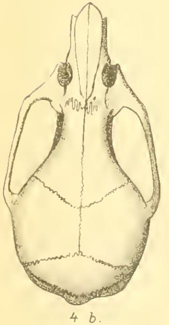

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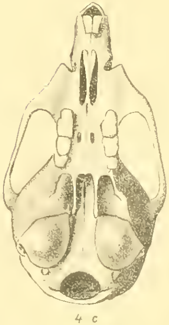

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ART. XIV.—*The Miocene Strata of the Gippsland Lakes Area.*

By J. DENNANT, F.G.S., and D. CLARK, B.C.E.

[Read 21st October, 1897.]

(With Plate VII.)

The marine miocene in the neighbourhood of Jemmy's Point was described by one of us in 1890,[1] and it was then advised that further explorations should be made in order to determine more precisely the boundaries of the area occupied by such strata. Some work in this direction has since been done by Mr. W. Gregson and ourselves, the results of which are now given.

Soon after the publication of the previous article, a junction of the miocene and eocene strata was reported as visible at Swan Reach on the Tambo, but we did not closely examine the section till a few months ago on the occasion of a holiday trip to the Gippsland Lakes. A road-cutting on the eastern bank of the river, and about 100 yards south of the Punt Crossing at Swan Reach, has exposed a tolerable thickness of the marine tertiaries. A peculiar feature of the outcrop and that which distinguishes it from junctions of similar strata noticed elsewhere, is that certain characteristic fossils of the two horizons mentioned are apparently mingled promiscuously together on the face, instead of being strictly arranged in the order of their geological age. Before, however, any explanation of this is attempted, it will be necessary to give further details concerning the section.

Though individual specimens are fairly numerous, the actual number of miocene species represented is very small, the following being the only ones we could find :—

Pecten antiaustralis.
Pecten meringæ.
Placunanomia ione.
Ostrea arenicola.
Cidaris sp. (spines).
Balanus amaryllis.

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[1] Proc. Roy. Soc. Vic., 1891.

The two pectens named are not only abundant but they are also exceedingly well preserved, both valves being not infrequently still joined. *P. meringae* is restricted to the Gippsland miocene and, though so plentiful in the Swan Reach section, is in others within the area a rare shell. *P. antiaustralis* is common both at Muddy Creek and in the miocene of South Australia, but we have nowhere seen finer examples than some of those collected here.

One or two of the stronger eocene shells, as *Spondylus gaederopoides* and *Pecten yahlensis*, though not as fresh looking as the miocene forms, are still in good condition, especially the latter, and they are besides the commonest of those found in the softer matrix, the eocene species generally, including also these two, being usually contained in nodules of limestone; for the most part the gastropods are represented by casts only, while with bivales the tests are frequently preserved.

It may be remarked here that the miocene fossils obtained were all either lying loose on the face or embedded in the calcareous sand, while none were found as casts. We did not observe them in the limestone, though it would not have been unusual if such had been the case, since at Jemmy's Point there is plenty of miocene limestone, both fossiliferous and unfossiliferous; indeed, some of the limestone bands in the upper part of the Swan Reach section are probably of miocene origin.

On our first visit to the locality we collected only two or three species of eocene fossils and of these very few individuals, as we merely picked up those easily seen from their having partially or entirely weathered out from the matrix, but on another occasion a special search was made for them, and by breaking up the limestone towards the base of the section we got a tolerable number, a list of which is given below. As they are nearly all casts, comparatively few of them can be definitely determined specifically.

Scaphander tatei ?
Bullinella exigua ?
Conus sp.
Voluta sp.
Trochus sp.
Dentalium sp.
Ostrea hyotis ?
Gryphaea tarda ?

Siphonalia ? sp.
Lotorium, two spp.
Semicassis transenna ?
Cassidaria sp.
Cypræa leptorhyncha.
Cypræa, two spp.
Tenagodes occlusus.
Calyptræa sp.
Cerithium sp.
Natica subinfundibulum ?
Natica sp.
Dimya dissimilis.
Pecten yahlensis.
Spondylus gæderopoides.
Lima bassii.
Panopaea orbita.
Casts of bivalves (indeterminate).
Waldheimia insolita.
Clypeaster gippslandicus.
Placotrochus deltoideus ?

We are informed that bones of whales were found here when the cutting was made, and that they were sent to Professor McCoy, but we cannot vouch for the statement; we saw no signs of any.

As may be gathered from a preceding remark, the eocene shells are most frequent in the lower part of the section, and this is specially the case from the base to about two and half feet up, but they also occur, though more sparingly, at a higher level. Moreover, at the foot of the cliff we were unable to find miocene fossils by digging, though they are plentiful enough above, and show here and there on the face all the way down. At the height just mentioned, viz., two and a half feet up from the road, there is a layer of sandy clay, mixed with magnetic iron oxide and titanic iron, running horizontally along the section, and it is possible that this may mark the actual line of contact between the upper and lower beds. Certainly, the strata beneath it, which consist mainly of a tolerably compact limestone similar to that on the cliffs of the Mitchell River, furnished nearly all the eocene fossils on our lists.

The cutting is about eighty yards long and slopes gradually at either end. In its deepest part it measures about forty-two feet from the road at its foot to the summit, to which may be added twelve feet of alluvium on the river bank just below.

The following are approximate measurements of the strata, which are arranged in horizontal layers :

		Ft.	in.
	Surface soil	10	0
	Gravel	4	0
Miocene fossils.	Calcareous sandy clay with two or three bands of limestone	25	0
	Band of sandy clay with ironstone gravel	0	6
	Calcareous sandy clay with limestone full of casts of eocene fossils	2	6
	Alluvium of river bank	12	0
	Total	54	0

The Tambo here is estimated to be only about four feet above sea level, though it is still at a considerable distance from its mouth at lake Victoria. The tide reaches at least thus far up the river, its marks being visible at the Punt.

Though the Swan Reach section is not, as will be shown later on, the most westerly outcrop of the miocene strata of the area, the deposits appear to thin out in that direction, whereas to the east they make strongly, and at Jemmy's Point, with those portions reckoned only which are certainly fossiliferous, a thickness of at least fifty or sixty feet is apparent. It marks also almost the northern boundary of the miocene, since as the Tambo is followed up for a short distance, the river cliffs which consist of hard limestone (the so-called polyzoal rock), are of eocene age. They form a part of, and are probably continuous with, the Bairnsdale limestones, which are, as is well known, characteristically eocene.

That a junction of the miocene and eocene strata is presented in the Swan Reach section is clear enough, and the only difficulty is as to how the intermingling of the shells in the manner described was brought about. Our theory concerning the section is that it represents a re-made bed, the eroded surface of eocene strata having formed the floor of the miocene beach. The limestone blocks containing casts of eocene fossils which lie beneath the ferruginous band, are probably *in situ*, while the casts and worn shells, which are mixed with well preserved miocene forms higher up, may be regarded as *derived* from the waste of the ancient shore line. The two eocene bivalves *Pecten yahlensis* and

Spondylus gæderopoides, would, from their solid structure, be less liable to injury than most other species, and this, no doubt, accounts for their occasional occurrence in the miocene sands as fairly perfect specimens; that they came originally from the limestone is undoubted, since not only did we find examples in the blocks broken up, but they are also common fossils in similar rocks on the eocene cliffs close at hand.

The re-arrangement of materials in a junction bed is of course common enough. For example, just *in* the nodule band at Muddy Creek, both eocene and miocene fossils are found, the latter predominating, while below it a few small miocene forms pass down into the older bed, and above, some proper to this transgress into the younger.

The presence of so few miocene species in the Swan Reach section is certainly remarkable, and can only be accounted for on the supposition that they were almost the only ones ever deposited on that particular portion of the old miocene beach. In the Gippsland miocene the distribution of species is doubtless partial, but this feature is nowhere else so marked as in the present section.

That the miocene in other parts of the area is also underlain by eocene strata may be reasonably inferred. To the north on the Nicholson and Tambo Rivers, the higher ground is occupied by eocene strata, which also crop out to the west at Bairnsdale, and again to the east on Lake Tyers. Though they are not seen between the latter locality and Swan Reach, there can be little doubt that they exist at no great depth beneath the miocene throughout the intervening distance.

In his "Notes on the Mitchell River Division," Mr. Howitt describes a set of beds which fill in a deeply excavated area at the contact of the Bairnsdale limestones and the Avon sandstones.[1] The beds here referred to overlie, as Mr. Howitt points out, the Mitchell River limestones at Boggy Creek and elsewhere. They are best known as the Moitun Creek beds, and consist of ferruginous sandstones, etc., containing casts of marine fossils, the precise age of which has not yet been conclusively decided. Some hundredweights of highly fossiliferous material have been lately gathered at one of the outcrops near Bairnsdale, and now await examination.

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[1] Prog. Report Geol. Survey of Vic., No. II.

A few forms can be easily made out, but others are obscure, and can only be determined by means of plaster moulds, which we have not yet had time to prepare. We therefore abstain just now from offering any opinion upon the actual relationship of these ferruginous beds to those discussed in the present paper, though we hope to be in a position to place our views before the Society at an early date.[1]

Allusion has already been made to outcrops of the miocene between Swan Reach and Bairnsdale. The most westerly of these is on the roadside close to the Nicholson River. But few fossils could be found, and all were very friable. They comprise the following species :—

Bullinella paucilineata.
Turritella tristira.
Dentalium sp.
Chione sp.
Corbula ephamilla.
Nuculana aff. N. Woodsii.
Tellina æquilatera.
Cucullæa corioensis.
Trigonia acuticostata.
Cardita spinulosa ?
Cidaris sp. (spines).

At Slaughterhouse Creek, about half way between the Nicholson and Tambo, the following were gathered, but they were also very poorly preserved :—

Dentalium sp.
Ostrea arenicola.
Pecten antiaustralis.
Pecten meringæ.
Placunanomia ione.
Corbula ephamilla.
Waldheimia sp.
And many indeterminable fragments.

Both of these are insignificant deposits, and are only mentioned on account of their position which is apparently just upon the fringe of the Jemmy's Point miocenes.

Southwards from Swan Reach on the shores of Reeves River at Meringa Creek, and Kalimna, a large collection was made in 1890, and these localities need not now be referred to. The other collecting grounds indicated on the map yielded numerous species, but no special interest attaches to any of the outcrops. One of the best sections for fossils is that at Lake Bunga, where they are both plentiful and well preserved.

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[1] Since writing the above the fossils have been sufficiently examined to enable us to recognise the ferruginous beds as miocene.

On the coast at the Red Bluff, and also between there and Lake Bunga, there is a great thickness of stratified calcareous sandstone overlain by clay and gravel wash, all unfossiliferous though probably also of miocene age. Similar unfossiliferous sandstones overlie the fossil bearing beds near Jemmy's Point, and form cliffs of about the same height, viz., from 50 feet up to 200 feet. No contact of the miocene with the adjoining eocene of Lake Tyers was observed; the most easterly locality noted as a collecting station is not far from Red Bluff, which is thus close to the *apparent* eastern boundary of the miocenes. Their disappearance in this direction is abrupt, since at Lake Bunga they show no signs of thinning out. It is possible indeed that, although they have not so far been observed, they may crop out again in places farther eastward. Certainly they are not seen on the road to Orbost, and the beds at Hospital Creek and on the Snowy River are characteristically eocene.

Inland, at Christopher Ritches', on the Mississippi Creek, the shells are exposed in a road cutting, from which, among the usual species, several not collected elsewhere in the area have at different times been obtained. As this creek is followed northwards the beds gradually thin out and disappear, while still further north, trappean rocks only were seen.

In crossing one of Ritches' paddocks near the Creek, we noticed the shells among the grass as if they had been turned up by the plough. Similarly at Roadknight's they show on some rising ground in earth thrown out of wombat holes. On the northern shores of the lakes almost every landslip discloses them in abundance, while the quarries and road cuttings in the vicinity frequently expose the fossiliferous sands and clays. The deposits are thus wide spread, and probably extend over a great part, if not the whole, of the area included between the approximate northern boundary of the miocene as marked on the map and the Lakes' margin; on the higher ground they are hidden from view by a moderate covering of pliocene and still later drifts. This boundary, which we have of course merely sketched out by connecting the several outcrops, would, if it could be accurately traced under the overlying sediments, represent the former outline of the miocene coast, only, instead of being nearly a straight line, it might perhaps prove to be as much broken by indentations as the present northern shores of the lakes.

Appended is a list of the species obtained from the various sections in the area since the publication of the previous article. In all, fifty-one additional species are here recorded, which bring up the total number now known from the beds to 167. A large proportion of the more recent gatherings are, so far, restricted to these beds; seven of the species are also constituents of the miocene fauna of Muddy Creek, while three or four, if not more, are still living in the adjoining seas.

Many of the new species here referred to are very handsome, and we hope before long they will be described in the Proceedings of the Society; among them are included a fine large volute, two elegant mangilias, one or two new tritons, a trigonostoma, new species of marginella, and a markedly distinct species of the curious little coral, for which the genus *Trematotrochus* was established by Tenison Woods.

In the former publication, the proportion of recent species of mollusca was estimated at sixteen per cent., and by omitting, as was done before, a few in the present list which are too worn for accurate identification, the percentage remains practically the same; it is certainly not increased.

The opportunity is now taken of making some necessary corrections in the 1890 list, as indicated in the columns below:—

ADDITIONS AND CORRECTIONS TO CATALOGUE OF FOSSILS.

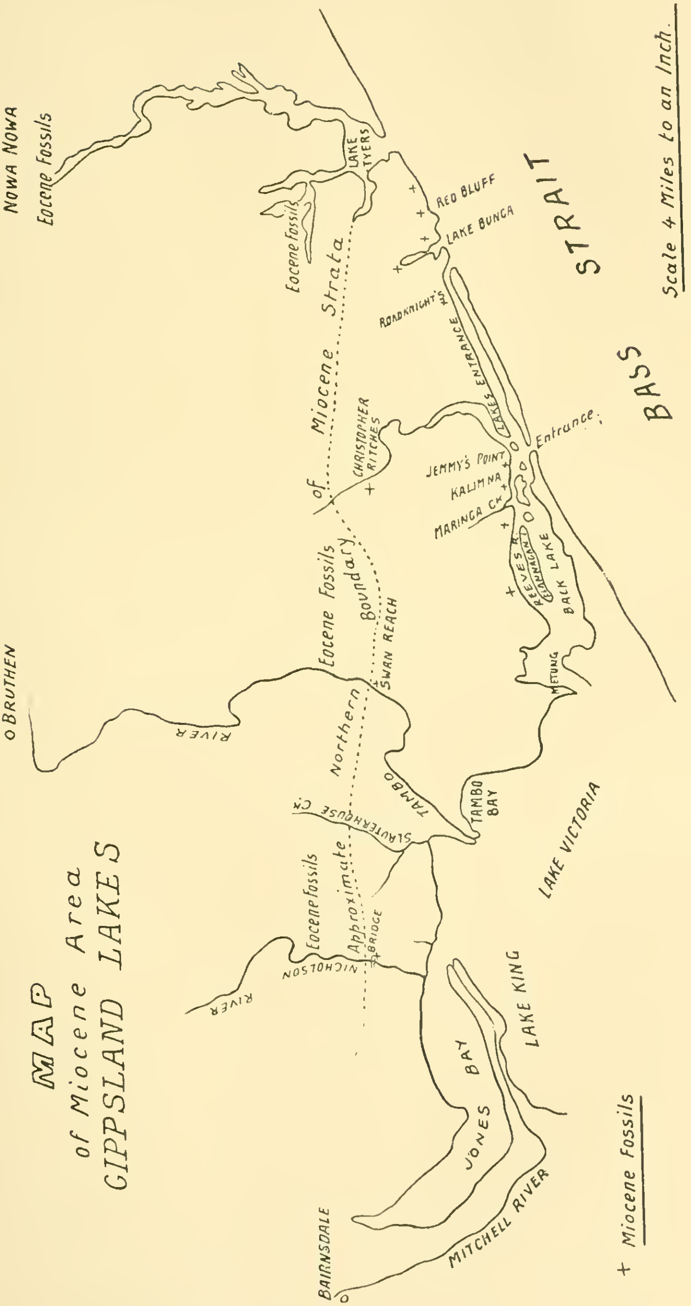
(Corrections of former List marked with dagger; names in italics under "Remarks" are those previously quoted).

Species in Gippsland Miocene.	Eocene.	Miocene.		Remarks.
		Muddy Creek.	South Australia.	
Actaeon sp.	-	-	-	(*aff.* A. funiculifer, Mioc., Muddy Ck.)
Terebra sp.	-	-	-	New species.
Conus hamiltonensis, *Tate*	*	*		
Bathytoma sp.				
Drillia trevori, *T. Woods*	*	*		
Drillia sp.	-	-	-	(*aff.* D. sandleroides).
Drillia sp.	-	-	-	New species.
Drillia two spp.				
Mangilia two spp.	-	-	-	New species.
Cancellaria sp.	-	-	-	New species.
Trigonostoma sp.	-	-	-	New species.
Marginella sp.	-	-	-	(*aff.* M. strombiformis).
Marginella sp.	-	-	-	(*aff.* M. tuberculosa).
Marginella sp.		-	-	(*aff.* unnamed sp., Mioc., Muddy Ck.)
Marginella sp.	-	-	-	New species.
Turricula sp.	-	-	-	(*aff.* T. schomburgki).
Voluta sp.	-		-	New species (*aff.* V. fusiformis).
Voluta sp.	-	-	-	(*aff.* V. conoidea).
Fasciolaria sp.				

Additions and Corrections to Catalogue of Fossils (*continued*).

Species in Gippsland Miocene.	Eocene.	Miocene.		Remarks.
		Muddy Creek.	South Australia.	
Fusus sp. - - - - - - -				
Latirus purpuroides, *Tate* - - -		*		
Tudicula sp. - - - - - -	-	-	-	New species.
Cominella sp. - - - - -				
Phos sp. - - - - - - -				
Columbella sp. - - - - - -	-	-	-	(*aff.* C. crebricostata).
Trophon sp. - - - - - -				
Purpura succincta, *Martyn* - -	-	-	-	Living Southern Australia.
Lotorium apicinum, *Tate*, *m.s.* - -	-	-	-	New species.
Lotorium sp. - - - - - -	-	-	-	(*aff.* L. verrucosum).
Lotorium sp. - - - - - -				
Bittium sp. - - - - - - -	-		-	New species (*aff.* B. granarium).
†Turritella tristira, *Tate* - - - -	*			*Turritella* sp.
†Turritella conspicabilis, *Tate* - -	*			*Turritella* sp.
†Turritella pagodula, *Tate* - - - -	-	*		*Turritella* sp.
†Calyptraea crassa, *Tate* - - - -	-	-	*	*Sigapatella undulata.*
Calyptraea sp. - - - - - -				
†Crepidula unguiformis, *Lane* - -	*	*	-	*C. monoxyla* and *C. immersa;* living Southern Australia.
†Natica cunninghamensis, *Harris* -	-	*	-	*Nom. mut.*, N. varians, *Tate*, non *Dujardin; N. gibbosa.*

MAP of Miocene Area GIPPSLAND LAKES



+ Miocene Fossils

Scale 4 Miles to an Inch.

ADDITIONS AND CORRECTIONS TO CATALOGUE OF FOSSILS (*continued*).

Species in Gippsland Miocene.	Eocene.	Miocene.		Remarks.
		Muddy Creek.	South Australia.	
†Natica subvarians, *Tate*		*	*	*N. ovata.*
†Natica subinfundibulum, *Tate*	*	*	-	*N. auriculata.*
Natica polita, *T. Woods*	*			
Natica substolida, *Tate*	*	-	-	Rare and small (*fide* Tate).
Natica perspectiva, *Tate*	*	-	-	One example (*fide* Tate).
Scalaria sp.				
Odostomia sp.				
Nerita melanotragus, *E. A. Smith*	-	*	-	Living Southern Australia.
Cyclostrema sp.				
Calliostoma sp.				
Dentalium sp.	-	-	-	New species (*aff.* D. sectum).
†Nucula antipodum, *Hanley*	-	-	-	Recent ; *N. tumida.*
Tapes sp.	-	-	-	New species (*aff.* T. fabagella).
Tellina sp.	-	*	-	Cheltenham ; new species.
Lucina fabula, *Reeve* ?	-	-	-	Living Southern Australia.
Lucina affinis, *Tate*	-	*	*	Cheltenham.
†Arachnoides incisa, *Tate*	-	-	-	*Arachnoides sp.*
Flabellum pedicellare, *Tate*, var.	*			
†Flabellum sp.	-	-	-	New species ; *F. victoriae.*
†Notocyathus australis, *Duncan*	*	-	-	*Sphenotrochus;* specimens well preserved.
Notocyathus excisus, *Duncan*	*			
Trematotrochus sp.	-	-	-	New species.

ART. XV.—*On a New Species of Victorian Mollusc (Coralliophila wilsoni).*

By G. B. PRITCHARD and J. H. GATLIFF.

[Read 21st October, 1897].

Coralliophila wilsoni, n. sp.

Shell small, biconic, acuminate posteriorly and anteriorly, consisting of a smooth embryonic portion of about a whorl and a half, succeeded by about five gradually enlarging somewhat angulate whorls.

Spire a little more than one-third the length of the shell. Spire whorls costate and angulate medially; eleven costæ on the penultimate whorl, costæ most strongly developed in the median portion of the whorl, rapidly thinning out towards both sutures; the sutures being well defined and rather deep; spaces between the costæ concave and about as broad as the costæ.

Body-whorl rather strongly angulate at the shoulder, which is situate in about the upper fourth of the whorl. Angulation and costation of the whorl tend to become somewhat less distinct towards the outer lip. Transverse to the costation over the whole of the body and spire-whorls, there are strong and apparently uniform spiral threads, bearing close erect forwardly projecting scales. The latter character is best seen on the body-whorl. The spaces between the spiral squamose threads are much narrower than the threads.

Aperture ovate, produced anteriorly into a short broad canal. Columella straight, smooth, and enamelled. Outer lip with a thin and much crenulated margin, crenulation of the margin extending to well defined grooves within the lip.

Umbilicus slight, margined by a strong tortuous ridge.

Shell of a brownish tint; aperture white with a faint pinkish tint, most distinct on the columella.

Operculum, horny purpuroid.

Dimensions.—Length, 12 mm.; breadth, 8 mm.; length of aperture and canal, 7 mm.; breadth of aperture, about 3 mm.; breadth of canal, about 1 mm.

Locality.—Dredged alive at Port Phillip Heads by the late Mr. J. Bracebridge Wilson.

Observations.—The species is named by us after the late Mr. J. B. Wilson, whose dredgings have added so much to our knowledge of Victorian Marine life.

The type is deposited in the Biological Museum of the University of Melbourne.

We hope to be able to figure this species with some others to be described later.

ART. XVI.—*Notes on Certain of the Initiation Ceremonies of the Arunta Tribe, Central Australia.*

By BALDWIN SPENCER, M.A., C.M.Z.S.,
University of Melbourne,

AND

F. J. GILLEN,
Sub-Protector of Aborigines, Alice Springs, South Australia.

[Read 11th November, 1897.]

In a previous communication to this Society we have already dealt with the Engwurra ceremony as performed by the Arunta tribe.[1] In the report of the work of the Horn Expedition to Central Australia one of us has also given a short account of certain of the initiation ceremonies, a more detailed description of which is included in the present paper. It must, however, be understood that the details of the ceremonies vary to a certain extent in different localities even within the limits of the one tribe, and the following account may be regarded as including the more important ones which are characteristic of the various ceremonies as they are conducted in particular localities.

It may be said that every Australian native, with possibly rare exceptions as in the case of the Wótjo-bálluk tribe of the Wimmera district, Victoria, described by Mr. Howitt,[2] has, in the normal condition of the tribe, to pass through certain ceremonies of initiation before he is admitted to the secrets of the tribe and regarded as a fully developed member of it.

In the case of the tribes inhabiting the east and south-eastern coastal districts of the continent the ceremonies appear to be entirely distinct from those of the tribes of the central area amongst whom they are very elaborate and spread over a long series of years, the first taking place at about the age of ten or twelve years whilst the final and most impressive one—that is the Engwurra—is not passed through until probably the blackfellow has reached the age of at least twenty-five or even thirty.

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[1] Proc. R. S. Vict., vol. x. (New Series), Pt. I., p. 17.

[2] Journal of Anthrop. Inst. London, May, 1885, p. 301.

In the Arunta tribe the ceremonies of initiation are four in number:—

(1) Painting and throwing the boy up.
(2) Circumcision or Lartna.
(3) Subincision or Ariltha.
(4) The Engwurra or fire ceremony.

One of the most noticeable features of these ceremonies, from a negative point of view, is the absence of the knocking out of teeth as a general custom associated with the initiatory rites. Amongst many tribes of the eastern coastal district this forms a prominent feature, but amongst the Central Australian natives whilst it may be performed it has nothing whatever to do with initiation and is in fact practised by women as well as by men, the rite having at the present day no "sacred" significance of any kind. Amongst certain local groups, as for example the natives living in the district now known as Bond Springs, a short distance to the north-east of Alice Springs, it is much more widely practised than elsewhere, but speaking generally the knocking out of teeth is a matter partly of individual and partly of local taste and fashion.[1] Possibly the custom may be regarded as one which was at some long-past time prevalent amongst the common ancestors of the central and eastern tribes, but has undergone changes as the tribes became separated from one another and developed, so far as their customs are concerned, along different lines. In some it has retained its old significance but in others, as for example all those inhabiting the central area, it has lost its earlier meaning, its place has been taken by other rites and now it is merely what may be called a "rudimentary custom."

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[1] It is, however, attended with the performance of definite ceremonies, and has evidently at one time been of greater importance than it is at present.

The First Ceremony.—Throwing the Boy up.

The first ceremony amongst the Arunta tribe takes place when, at all events in the northern part of the tribe, a boy is between ten and twelve years of age. The men, and also the women, assemble at a spot near to the main camp and the boys who have reached the right age are taken one by one and tossed in the air several times by the men who catch them as they fall while the women dance round and round swinging their arms about and shouting "pow" "pow" "powa-a-a," the last cry being very prolonged. When this is over the boys are painted on their chests and backs with simple designs, consisting of straight or curved bands outlined by lines of red or yellow ochre. So far as we can discover these have no special significance, they certainly have no reference to either the class[1] or totem of the boys.[2] The painting of each boy is done by one or more men who stand to him in the relationship of "umbirna," that is a man who is the brother of a woman of the class from which his, *i.e.*, the boy's, wife must come. The design is called "Enchīchīchĭka," and while being painted the boys are told that the ceremony through which they have just passed will promote their future growth to manhood, and they are told by tribal fathers and elder brothers that in future they must not play with the women and girls, nor must they camp as they have hitherto done with them but must henceforth go to the camp of the younger and unmarried men which is known as the "Ungunja." Up to this time they have been accustomed to go out with the women as they searched for vegetable food and the smaller animals such as lizards and rats, now they begin to accompany the men in their search for larger game and begin also to look forward to the time when they will become fully initiated and admitted to all the secrets of the tribe which are as yet kept hidden from them.

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[1] We use the term "class" in reference to the intermarrying, exogamous divisions of the tribe.

[2] In all the ceremonies of initiation the youth or man has certain designs painted on his body, and in no case have they any reference of necessity to his own totem though they are emblematic of some totem with which usually the man who does the painting is associated. These designs come under the general term of "Ilkinia" the name applied to the series of designs which are emblematic of the various totems and, so long as the boy, youth or man has one or other of these painted on, it does not signify which. It must be remembered that the man who does the painting is the person who decides upon the nature of the design. It may also be noted that in the performance of sacred ceremonies men are constantly decorated with designs belonging to totems other than their own.

The ceremony of throwing up is called "Alkirakiwūma"[1] and very shortly after this the boy has his nasal septum bored through, usually by his father or paternal grandfather, and begins to wear the nose bone. This boring is practised by men and women alike and the operation is not attended with any special ceremony. Amongst the women the boring is usually done by the husband immediately after marriage and, it may be remarked in passing, that in both sexes the constant wearing of the nose bone emphasises the flattening out of the lobes of the nose.

A good many years may elapse between the throwing-up ceremony and the performance of the two much more important ceremonies of circumcision or Lartna and that of subincision or Ariltha. Speaking generally it may be said that circumcision may take place at any age after the boy has arrived at puberty. Up to this time he is spoken of as "Ulpmerka," after the two ceremonies have been performed he becomes an "Ertwa-kurka" —that is an initiated man eligible to take a wife and to be admitted to all the tribal secrets, though it may be many years before he is instructed in certain of them.

The Second Ceremony.—Circumcision or Lartna.

When it has been decided by the boy's elder male relatives (usually his elder brothers blood and tribal) that he has arrived at the proper age, preparations are made, unknown to the Ulpmerka, for the ceremony. These consist first of all in the gathering together of a large supply of food material, for the ceremonies are attended with the performance of what are usually spoken of as corrobborees, which last over several days.

In the following account[2] which deals with the ceremony as enacted by the natives living on the banks of the Finke near to a spot called Undiara, one of the most important local centres of the kangaroo totem, we omit certain details which would necessitate for their proper understanding too lengthy a reference to traditions dealing with the past history of the tribe. In the performance of every ceremony the Arunta native is bound hand and foot by tradition, what his fore-fathers did that he must likewise do, and in connection with every custom, however trivial, he has some tradition telling him exactly how he must act and what he must do.

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[1] Derived from Alkira, the sky, and wuma, to throw.

[2] In certain respects the details of the ceremony now described differ from those of the ceremony already described by one of us in the Report of the Horn Expedition. This is owing to the fact that the details vary to a considerable extent in different localities.

We may, however, very briefly refer here as follows to certain of the traditions which have reference to the ceremonies of initiation; a full account of them will be published subsequently.

The earliest period to which any tradition refers is always spoken of by the natives as the "Alcheringa." At the very beginning of this, so says tradition, there were no true human beings such as now exist but only "Inapertwa,"[1] that is almost shapeless beings in which just the vague outlines of the different limbs and parts of the body could be detected. Two spirit beings who lived far away in the western sky and who were called "Ungambĭkŭlla," a word which signifies "made out of nothing," or "self-existing," came down to earth and transformed the Inapertwa creatures into men and women, and further they performed upon some but not all of them the rite of circumcision, using for the performance of the operation a fire-stick. It is worthy of note that this tradition of the early use of the fire-stick is widely spread through the various divisions of the Arunta tribe. At a slightly later period, but in the Alcheringa, certain ancestral individuals who belonged to the Ullakupera, or little hawk totem, introduced the practice of performing the operation by means of a stone knife. Shortly after this, individuals belonging to the Achilpa, or "wild cat" totem, introduced the rite of Ariltha or subincision.

It will be seen from this, which is the briefest possible outline of lengthy traditions dealing with the subject, that the traditions of the tribe refer to three distinct and successive periods: (1) one in which circumcision was practised by means of a fire-stick, (2) one in which the use of the stone knife was introduced, and (3) a later period when subincision was introduced.

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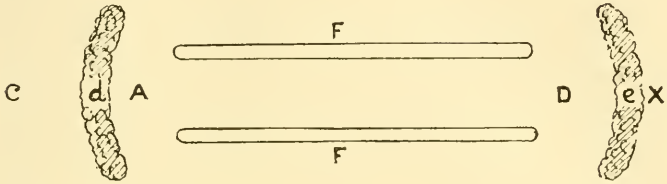
[1] In the Report of the Horn Expedition, vol. iv., p. 185, this word was by mistake written "Inaperlwa." The spelling and account now given are correct.

At the present day the operation of circumcision is always performed at a specially prepared spot to which the name of "Apulla" is given. The nature of this can be seen from the accompanying plan.



A path about five feet wide is cleared of grass and shrubs and the surface soil is heaped up on either side so as to form a low narrow bank (F F) of the same length as the path. The latter is always made so that it runs east and west. At a distance of about fifty yards from either end a small brake of boughs is made (d, e).

When all has been properly prepared the youth to be initiated is seized early during the evening, while he is at the Ungunja or camp of the men. This seizing of the youth is the duty of men who stand in a certain definite relationship to him, viz., that of (1) Okilia, or elder brothers, (2) Umbirna, or brothers of his future wife, (3) Unkulla, or sons of his mother's brothers.[1] As soon as they lay hands on him they shout loudly "Utchai," "Utchai." Not infrequently the youth, thoroughly frightened, struggles violently and tries to escape in which case he is simply carried off bodily to the Apulla ground. Once on the ground and in the presence of all the men and women who have assembled there he makes no further resistance but seems to resign himself to his fate. The men are gathered together at the eastern end of the Apulla close by the brake at the spot marked A in the diagram, while the women are at the spot marked C.

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[1] In the northern part of the tribe all the men and women assemble at the Apulla ground while the boy is asleep, and then three men and two young women are sent to awake and bring him in. The women carry shallow "pitchis" or wooden bowls, with which, after creeping quietly up to him, they strike him sharply at the same time crying out loudly "Utchai." Then the three men seize and carry him off.

The youth who is as yet spoken of as Ulpmerka, that is an uncircumcised boy, sits down amongst the men while the women who have been awaiting his arrival at once begin to dance, carrying shields in their hands. The reason assigned for this is that, in the Alcheringa, certain women called Unthippa carried along with them, as they travelled over the country, a number of young boys who were just being initiated. As they travelled along they also carried shields, dancing the whole time, and therefore it is that, at the present day, the initiation ceremony must commence with an imitiation of the Unthippa dance of the Alcheringa. Except upon this one occasion women never carry shields, which are exclusively the property of the men. While the women are dancing the men sing of the marching of the Unthippa women across the country, and after the boy has watched and listened for some little time his head is covered with strands of fur string so as to give it the appearance of being encased in a tightly fitting skull cap. A large Uliara, or human-hair girdle, is also placed round his waist by a man who is Gammona, that is mother's brother to him, the girdle itself being provided by a man who is Oknia[1] or "father" of the boy.

When this has been done a consultation of the men who are Oknia and Okilia to the boy is held, and certain other men are told off by them to take the boy away and paint him. These men are always afterwards called Wutya or Wilya by the boy. After the consultation is over they go away and, first of all, build a brake of bushes at the western end of the Apulla, after which they return and, taking the boy, lead him through the dancing women to the brake, where some time is spent in greasing his body and decorating him with a pinkish coloured clay and lines of bird's down. When this is over the Wilya men tell the boy that he is no longer an Ulpmerka but is now a Wurtja, that during the proceedings about to follow, he must render implicit obedience and on no account must he ever tell any woman or boy anything of what he is about to see. Should he ever reveal any of the secrets both he and his closest relations will surely die. He is not to speak until spoken to and even then only in a subdued voice; when left at his brake—that is the one at which the painting has been done—he must always crouch down and on no account attempt to see what the men are doing. Should he try to see what is going on at the Apulla, except when taken there and told to watch, some calamity will happen to him—Twanyirika, the great spirit, whose voice is heard when the bullroarers speak, will carry him away. When these instructions have been given to him by the Wilya, some Okilia come to him and repeat them over and over again. After this he is left entirely alone behind his brake at the spot marked X for an hour or two while the singing and dancing are continued with vigour. Meanwhile the Oknia and Okilia again consult and choose a man who is Mura to the boy to act as what is called "Urinthantima." Towards daylight the boy, now called Wurtja, is brought back to the men from his brake, passing through the group of women who have not yet ceased dancing, and is placed upon the lap of the Urinthantima man.

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[1] It must be remembered that we have no equivalent expressions in English for the native terms of relationship; thus, for example, Oknia includes not only the man whom we call father but also all the men who were eligible as husbands for the boy's mother.

The boy's mother has previously brought from her camp a fire-stick which she is careful to keep alight all night. In the early morning she lights a fire with this and then lights two long sticks with which she has provided herself. These she holds in her hands as she sits behind the Urinthantima, one she hands to the Tūalcha-mūra woman[1] of the boy and the other she retains and takes back with her to camp where she is most careful to guard it constantly and to keep it alight. It is fixed into the ground at an angle so as to catch the wind. The Wurtja guards his fire in just the same way, and is cautioned by the men with him that if he loses it or allows it to go out he and his mother will be killed by Kurdaitcha. On the day on which he is led back to the Apulla he throws away the fire-stick as also does his mother.

While the men are singing a special fire song, the woman who is Tūalcha-mūra to the boy approaches and ties round his neck bands of fur-string after which she hands to him the fire-stick which she has received from the boy's mother. The latter has taken up a position along with the sisters of the boy's father immediately behind the Urinthantima man. The woman tells the boy to always hold fast to his own fire—in other words not to interfere with the women who have been allotted to other men. After this, and at a signal from an old Okilia, the Wurtja gets up and runs away followed by a number of shouting boys who after a short time return and, along with the women, leave the Apulla ground and run back to the main camp.

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[1] The Tualcha-mura is the woman whose daughter, born or unborn, has been allotted to the boy as a future wife, so that she is potentially his mother-in-law.

The Wurtja is accompanied by some Okilia and Unkulla men who remain out with him in the bush for usually three days. During this time nothing of any special nature happens to him beyond the fact that he may not speak unless spoken to, and that he is not allowed to eat freely, though he is not as yet bound by the food restrictions which he will very shortly have to obey. The main object of this partial seclusion is to impress him with the fact that he is about to enter into the ranks of the men, and to mark the break between his old life and the new one; he has no precise knowledge of what is in store for him and the sense of something out of the ordinary being about to happen to him—something moreover which is of a more or less mysterious nature—helps to impress him strongly with a feeling of the deep importance of strict compliance with the tribal rules and further still with a strong sense of the superiority of the older men who know and are familiar with all the mysterious rites, some of which he is about to learn the meaning of for the first time.

When brought back to the Apulla, the Wurtja is placed first of all behind the brake at the west end of the ground from where he may not move without the permission of his Okilia. The Apulla ground is in charge of a man who is an Oknia of the boy. On this, the fourth night, the men spend the time, hour after hour, singing of the marching of the Ullakupera men in the Alcheringa, and of their operations with their celebrated Lalira or stone knives. Every now and then they break out into the Ullakupera Lartna song:

"Irriyulta yulta rai
Ul katchera ulkatcherrai."

Which is always sung in fierce, loud tones. About midnight two Okilia go to the Wurtja and having blindfolded him bring him to the group of men where he is made to lie, face downwards on the ground, until two men who are to about to perform a ceremony are in position between the lines of the Apulla. The quabarra[1] which they are about to perform is one of a certain number which are only performed at times such as this when initiation is taking place. When the boy is told to look up he sees lying in front of him and on his side a decorated man, whom the Oknia and Okilia, both speaking at once, tell him represents a wild-dog. At the other end of the Apulla another decorated man stands with his legs stretched wide apart and holding twigs of eucalyptus in each hand; his head is decorated with a small ornament called a Waninga to which further reference will be made subsequently. The performer moves his head from side to side as if looking for something and every now and then utters a sound similar to that made by a kangaroo, which animal he represents. Suddenly the dog looks up, sees the kangaroo and begins to bark. Running along on all fours he passes between the legs of the kangaroo man who strikes him with the twigs, after which he lies down again for a minute or two behind the kangaroo who keeps watching him over his shoulder while he utters the sound. Then the dog gets up, runs from behind between the kangaroo's legs, is caught by the head, shaken, and howls as if in pain while a pretence is made of dashing his head upon the ground. This is repeated several times and finally the dog is supposed to be killed by the kangaroo. Then the dog runs quickly on all fours to the Wurtja and lies down on the top of him; he is at once followed by the kangaroo who hops on to the top of the dog and so the Wurtja has to bear the weight of both men for about two minutes. When they get up, the Wurtja, still lying down, is told by the old men that the quabarra represents an incident which took place in the Alcheringa when a wild-dog man attacked a kangaroo man and was killed by the latter. The object which the kangaroo wore on his head was, he is told, a Waninga, a sacred object, the name of which must never be mentioned in the hearing of women or children, and that, in fact, it represents a kangaroo. When this is over the Wurtja is led back to his brake and the men continue singing at intervals nearly all night.

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[1] Quabarra is the term applied by the Arunta natives to sacred ceremonies which only initiated men may witness.

The quabarra which are performed at these initiation ceremonies vary according to the locality in which they are being performed and the men who are taking the leading part in them. If, for example, the old man who is presiding belongs to the Emu totem then the quabarra will, at all events to a certain extent, represent incidents concerned with ancestral Emu men. In the particular ceremony upon which the present account is based, the old man presiding belonged to the Kangaroo totem and thus quabarra concerned especially with this totem were much in evidence. The totem of the youth who is being initiated has no influence whatever on the nature of the particular quabarra performed. Each old man who presides over, or takes a leading part in, a ceremony such as this has possession of a certain number of quabarra and naturally those performed are chosen from this series. Remembering, therefore, that the particular quabarra vary from ceremony to ceremony, the account now given may be regarded as representing in essential features the details of the initiation ceremony of circumcision amongst the Arunta tribe. At the same time it is also necessary to remember that ceremonial objects, such as the Waninga, which figure largely in some districts are unknown in others where their place is taken by entirely different objects. Thus, for example, in the northern part of the tribe a sacred pole called a Nurtunga is used and this, where it is used, has precisely the significance of the Waninga which is never met with in the northern districts. For an outline of an initiation ceremony in which the Nurtunga is used reference may be made to the account already written by one of us in connection with the ceremony of subincision amongst the northern Arunta.[1]

On the next day another quabarra is performed, this time by two kangaroo men and one man representing a dog. Once more the dog is killed (it may be mentioned here that in similar ceremonies associated with the wild-dog totem it is the kangaroo which is killed), finally the three men throw themselves on top of the Wurtja, after which the latter is once more told by the old men what the ceremony means and is again taken back to the brake at the western end of the Apulla.

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[1] Report of Horn Expedition to Central Australia, vol. iv., p. 173.

On the sixth day the Wurtja is taken out hunting by Okilia and Umbirna, and the succeeding night is spent by the men in singing songs, to which the Wurtja listens and which have reference to the wanderings of certain Alcheringa ancestors.

We have in our previous account of the Engwurra ceremony[1] dealt briefly with the traditions which are concerned with the wanderings of various groups of individuals and have described the connection of these with the totemic system as developed in the Arunta tribe. Up to the time of his initiation the youth has known nothing of these traditions and now for the first time he hears of them and sees the ceremonies performed in which the ancestors of the tribe are represented decorated as they were, and acting as they did, during life. In various accounts of initiation ceremonies of the Australian tribes, as for example, in the earliest one ever published—the one written by Collins in 1804—we meet with descriptions of performances in which different animals are represented but, except in the case of the Arunta tribe, no indication of the meaning and significance of these performances has been yet forthcoming. In the Arunta tribe however they are seen to have a very definite meaning and to be intimately associated with the totemic system. Whether this be so in other tribes we have as yet no evidence to show, but it is, at all events, worthy of note that, whilst the actual initiation rite varies much from tribe to tribe, consisting in some in the knocking out of a tooth, and in others in circumcision, etc., in all an important part of the ceremony consists in showing to the novitiates certain dances, the important and common feature of which is that they represent the actions of particular animals. In the Arunta tribe however they have a very definite meaning. At the first glance it looks much as if all that they were intended to represent was merely the behaviour of certain animals but in reality they have a much deeper meaning, for each performer represents an ancestral individual who lived in the Alcheringa. He was a member of a group of individuals, all of whom, just like himself, were the direct descendants or transformations of the animals, the names of which they respectively bear. It is as a re-incarnation of the never-dying spirit part of one of these semianimal ancestors that every member of the tribe is born, and therefore when born, he or she, bears of necessity the name of tne animal, or plant, of which the alcheringa ancestor was a transformation or descendant.

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[1] Proc. R.S. Vict., vol. x., pt. i., p. 17.

The nature of these performances may be gathered from one which was, in this instance, enacted on the seventh day. As usual in all these performances the man's body is decorated with ochre and lines of bird's down, which is supposed to be arranged in exactly the same way in which it had been on the body of the Alcheringa man. From the waist is suspended a large ball of fur-string which is supposed to represent the scrotum of the kangaroo, and when all is ready, the performer, who has been decorated behind the brake where the men sit, comes out hopping leisurely along as a kangaroo does, and every now and then lying down like the animal on his side to rest. The boy, as before, has been brought, blindfolded, on to the ground and at first is made to lie flat down, but, when the performer hops out, he is told to sit up and watch. The performer for about ten minutes goes through the characteristic movements of the animal, acting the part very cleverly, while the men sitting around the Wurtja sing of the wandering of the kangaroos across the country in the Alcheringa. Then after a final and very leisurely hop round the Apulla ground the man comes and lies down on top of the Wurtja who is then instructed in the tradition to which the performance refers. He is told that in the Alcheringa a party of of kangaroo-men started out from a place called Ultainta away out to the east of what is now called Charlotte Waters, and that after wandering about they came at last to a spot called Karinga, far away to the north in the Macdonnell Ranges, where one of the party who was named Unburtcha died, that is his body did but the spirit part of him was in a sacred Churinga which he carried, and did not die but remained behind when the party travelled on. This spirit, the old men tell him, went at a later time into a woman and was born again as a Purula man, whose sacred name was of course Unburtcha, and who was a kangaroo-man just as his ancestor was. He is told that the old men know everything about these matters and decide which ancestor it is who has come to life again in the form of a man or woman. Sometimes the spirit child which goes into a woman is one which was associated with one of the sacred Churinga, numbers of which each Alcheringa individual carried about with him or her, for in those days the women were allowed to carry the Churinga just like the men, and then, in this case, the child has no definite name but, of course, it belongs to the same group as did the man who had carried the Churinga about in the Alcheringa, that is if he were a kangaroo-man so must the child be, and then the old men determine what shall be his secret or sacred name.

It is in this way that the boy during the initiation ceremonies is instructed for the first time in any of the sacred matters referring to the totems, and it is by means of the performances which are concerned with certain animals or rather, apparently with the animals, but in reality with Alcheringa individuals who were the direct transformations of such animals, that the traditions which deal with this subject which is of the greatest importance in the eyes of the native, are firmly impressed upon the mind of the novitiate to whom everything which he sees and hears is new and surrounded with an air of mystery.

After the completion of this kangaroo ceremony the Wurtja is taken back to his brake, and then a consultation of the Okilia and Oknia is held for the purpose of selecting a man to perform the operation and also a man to assist the chief operator. Both these men are called "Atwia-twia," and in addition to them a man is selected whose duty it is to hold up the shield upon which the boy is seated during the operation, this man being known by the name of "Elucha." The conversation is carried on in whispers, the men when speaking placing their mouths against each other's ears. While this consultation is in progress, the other men sitting close to the brake sing in fierce, loud tones, the Ullakupera Lartna song—"Irriyulta yulta rai, etc."

After some little discussion it is decided that an old man who is Mura to the boy is to act as "Atwia-twia," and that a man who is Gammona to him is to act as his assistant, his duty consisting in pulling forward the fore-skin, while another old man who is Ikuntira[1] to the boy is to be the shield bearer or Elucha. It must be remembered that in addition to the honour attaching to these offices there are certain emoluments, for when the operation is all over the boy has to provide each of these men with an offering of food.

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[1] Ikuntira is the name given to actual or tribal fathers-in-law.

As soon as the decision has been made the singing stops, and the men arrange themselves in a line in front of the brake while the three Okilia sit opposite to them at the end of the path looking especially grave as if the business now to be performed were of the deepest importance.

Each one of the three now gets up in turn and leads forwards one of the appointed officials, who all make a show of reluctance, and places him in front of the row of men who are seated in a line beside the Apulla so that now there are two rows of men facing one another. The old Mūra man sits in the middle of his row and opposite to him is the oldest of the Okilia. The latter with his hand smooths the surface of the ground between the two lines and then, picking up a spear-thrower by the end to which the point is attached, he thrusts his beard into his mouth, as does also the Mūra man, and both glare fiercely at each other. Then without taking his eyes off the Mūra man he scoops up, with the chisel end of the spear-thrower, a little soil, and gliding along on his knees empties it into the hands of the former. Then he embraces him, rubs their bodies together and finally rubs his forehead against the stomach of the Mūra man. After this he repeats the whole performance with the two other officials, and when this is over the three old men are embraced in the same way by the other Okilia, who however do not present them with dirt.

The meaning of the latter ceremony is to imply that the youth is intrusted to them for the purpose of being initiated, with as little hesitation as the dirt is placed in their hands.

This little ceremony is called "Okoara" and is conducted with much solemnity. When it is over the men join the others and once more the Lartna song is sung with much fierceness. Singing is kept up all night with short intervals; the Wurtja is brought from his brake early in the evening and sits the night long amongst the men listening to, but taking no part in, the singing.

The morning of the eighth day is spent in preparing for a ceremony concerned with the "Illuta" (a rat) totem. The particular rat-man or man-rat, for, as already said, the identity of the human individual is sunk in that of the object with he is associated and from which he is supposed to have originated, to whom this ceremony refers is reported to have travelled in the Alcheringa from a place called Pulkira west of the Finke River to Walyirra, where he died and where his spirit remained, associated as usual with a churinga. In connection with this ceremony a large Waninga is made. This consists of a spear, across which, close to each end, a short bar of wood is attached; strands of human hair string pass along from bar to bar, closely side by side and at each end pass off slant-wise towards the central spear. The whole structure is supposed to represent the body of a rat. The main part is supposed to be the trunk of the animal, the point end of the spear is the tail, and the handle end is the head. The Waninga is carried by one of the Okilia men while another man walks behind to steady it. Two other men are decorated so as to represent two "Kutta Kutta" or little night hawks. When all is ready the Wurtja is led, blindfolded of course, to where the main body of men are seated. The performers approach from the south side making a circuit and walking with their backs towards the Apulla until they are opposite and about thirty yards away from the Wurtja when the bandage is quickly taken from the eyes of the latter. Then the two "Kutta Kutta" men with both legs stretched wide apart and hands holding a stick across their shoulders, come along between the lines of the Apulla with a curious quick, gliding movement, towards the audience and then rapidly retire. Then the men with the Waninga run down the lines, stopping every now and then as they bend the Waninga over towards the Wurtja but without touching him; then they stand erect and perform the quivering movement which is such a characteristic feature in all the native ceremonies. This is done several times and finally all four performers come into the Apulla lines at the same time, the "Kutta Kutta" men being at first in front, then they retire to the side and the men bearing the Waninga come on close to the Wurtja when a man steps out of the audience, touches the performers and the ceremony comes to an end. Then a man who is an Ikuntira, that is a possible father-in-law, to the Wurtja takes the Waninga and fixes it upright in the Apulla path, and the Wurtja is told by the Oknia and Okilia men, who, as usual, sit close to him during the performance, to go out and embrace the Waninga which he does for some minutes, the

Waninga carriers standing close by and the men at the brake singing of the Waninga and of the walking of the Illuta in the Alcheringa. Then the Wurtja is told to lie down again and his head is covered over, the usual instructions and cautions being given to him. During this time another ceremony is being prepared of a simple description as no decoration is used. The men occupy the time in singing about a party of Alcheringa individuals who started to walk from a place called Ayaiya. After the singing has gone on for about an hour the Wurtja is told to look up and he sees a number of men lying about the Apulla ground; as he looks up they begin to hop about and to utter the sounds made by kangaroos. One old man in particular is noticeable from the way in which he imitates the movements of an old disabled animal. After hopping in and about the Apulla for some minutes they bunch up together at the western end of the ground and then suddenly rising with a loud shout of "pow, pow, pow," they run away to a small gully out of sight of the Wurtja who is told that these men represent a party of Alcheringa kangaroo-men starting off from Ayaiya. After this and while further preparations are being made the Wurtja remains with the audience but has his head covered. The tradition dealing with this special group of kangaroos relates that the party split into two, a larger and a smaller one, and that the larger one travelled on ahead of the other one. When preparing for the ceremony the bodies are first of all rubbed all over with red ochre, then two young men open veins, first in one arm and then in the other, and allow the blood to flow out in a stream over the heads and bodies of the men who are about to perform. The latter who are ten in number are then ornamented with little patches of down but, unlike the usual plan of ornamentation, there is no regular pattern made, the reason for this being that the Alcheringa men had not used any regular pattern.

When all are ready, they go, with the exception of three who stay behind, on to the Apulla walking in single file and carrying twigs of Eucalyptus in their hands. When they reach the ground a young man who leads the column and represents a young and frolicsome kangaroo which, according to tradition, accompanied the marchers, lies down sideways across the entrance to the path with his back turned towards the Wurtja. The other men stand in the path with their legs wide apart shifting their heads from side to side and making the twigs quiver. Then the Wurtja is told to sit up and the performers at once greet his appearance with imitations of the sounds made by kangaroos; then the young kangaroo, called "Kulla Kulla," begins frisking about pretending to rush at the other performers, and finally darts between the legs of each man and emerges at the western end of the column where he lies down quietly for a minute or two. After he has done this four times he is caught up as he comes through the legs of the man who stands nearest to the Wurtja and is carried up to the latter and placed upon him and then all the other performers throw themselves upon the top of him so that the Wurtja has actually to bear the whole mass of men. (The Wurtja himself on this particular occasion did not appear to be any the worse for this trying experience, but one of the performers fainted as soon as they extricated themselves. The stoical calmness of the young Wurtja was most marked throughout the whole ceremony). The performers then seat themselves amongst the audience and the remaining three men then come on and go through the same performance, one of them personating a young kangaroo as before. The latter is again laid on top of the Wurtja and the other two men lie on the top of him. For this lying down on the top of the novitiate there is a special term—"wulthachelpima." After the usual explanations and cautions the Wurtja is again led back to his own brake by his Okilia. During the evening when the men are assembled at the Apulla he is brought back and lying down listens to the singing which continues with little interruption during the whole night.

On the morning of the ninth day the Wurtja is carefully greased all over by the elder Okilia in whose special charge he is and remains crouching or lying down at his brake until noon when he is blindfolded and brought to the Apulla. Then the kangaroo performance of the previous day is again enacted, the performance including the lying down upon the Wurtja. After this two more kangaroo ceremonies are performed the second of which is of some importance. The principal performer carries a large Waninga on the top of which a smaller one is attached, the large one representing a full grown kangaroo, and the smaller one a young one. As on a previous occasion the Waninga is taken by a man who is Ikuntira to the Wurtja and fixed in the ground and then the latter is told by his Oknia and Okilia to go and embrace it which he does for some minutes, the performers meanwhile standing round. The showing of the Waninga to the Wurtja is called "umba-keli-irrima" which means "the child sees and knows." The embracing of the Waninga is called "eliaqua erkuma." After the performance the Wurtja is once more instructed as to what the Waninga means, and cautioned not to reveal anything to women or to uninitiated boys; then as usual he is made to lie down and in fierce tones the men sing the Lartna song—"Irriyulta yulta," striking the ground with their shields. Then the Wurtja is taken back to his brake were he remains until about nine o'clock at night when he is brought to the Apulla and there his head is decorated with stalks of cane grass, while at the same time the other men decorate themselves in the same way and in addition have stalks inserted beneath their arm bands.

When this has been done the brake of boughs at which the men assemble is built higher and the men all crouch behind it. Then at a signal from an Oknia the women approach shouting as they do so "pai! pai! pai," and taking possession of the Apulla ground, dance upon it for some minutes and then leaving the Apulla go to one side when the men come out and stand on the Apulla. The women then come and join the men who dance round while the women pluck the grass stalks from their heads, shouting as they do so, "pai! pai! pai!" While this is going on the men all dance with their faces turned towards the east as in the stripping dance at a later time, one or more women behind each man. The mūra woman, who is called "unchalkulkna," after stripping the Wurtja who has been dancing amongst the other men, suddenly stops and placing her head through his legs from behind hoists him on to her shoulders and runs off with him followed by all the other women, to a spot behind and in a line with the Apulla from which it is distant about fifty yards. Here she places him sitting on the ground and then sits behind clasping him in her arms, some Mias and Uwinnas sitting close behind her. The other women continue to dance in front of the Wurtja shouting, "pai! pai! pai!" and making a movement of invitation by slightly lifting the hands up and down, with the arms bent at the elbow, in a way often adopted during various ceremonies.

At the Apulla the men sit down and sing the fire song :—

"Atnylinga etunja illa althara wuntama,"

over and over again. Atnylinga is the red flower of a species of Eremophila which in the Alcheringa was made red by much burning, Etunja is a twig of Eucalyptus, Althara means blazing up, and Illa wuntama is the term applied to a fire which is rushing along. This song is always sung on the night preceding the preparation of the Arachitta poles, the twigs used for swathing which are always put through a blazing fire. The singing continues for about half-an-hour, after which the Urinthantima man as well as another mūra man, and also an Okilia, run to the lubras holding shields before their faces. The first-named seizes the Wurtja, and assisted by the other two takes him back to the Apulla, where he is told to lie down and his face is covered, while the singing of the fire song continues at intervals all night long. As soon as the Wurtja is taken from them the women run away to their camp.

At daybreak the Urinthantima man rubs the Wurtja all over with dry red ochre and then winds fur-string round his head so as to completely hide his hair from sight while the other men sing :—

"Purta purta airpinta airpintima,"

The song sung while preparing the Arachitta poles. Purta purta is to arrange the leaves, to settle them in their places ; Airpinta airpintima means round and round again. While this is being sung the women come up to the Apulla and dance up the lines towards the Wurtja making with their hands the movement of invitation and shouting, "pai ! pai ! pai !" Suddenly the Urinthantima man hoists the Wurtja up on his shoulders and runs off with him followed by a number of the younger men upon which the women at once run back to their camp and the singing ceases. When out of sight of the Apulla the Wurtja is put down and the men proceed to a spot about half-a-mile away from the Apulla where they make large fires and cut down a number of slender sapplings which are to be used for Arachitta poles. The branches are scorched in the flames while the men sing the fire song:—"Atnylinga etunja, etc." When sufficient material has been secured they sit down and begin to tie twigs on to the poles, the men singing, incessantly, "Purta purta airpinta airpintima." When the poles, about thirty in number—each of them about ten feet long—are ready, which is about noon, the men start back for the Apulla carrying the poles with them. These they place in a heap about two hundred yards from the Apulla, and then the Urinthantima man assisted by an Okilia ties twigs of Eremophila round the boy's body and on to his head—this being done where the sticks have been deposited. A signal is communicated to the men at the Apulla who then move away and shout to the women who are waiting some little distance off and who then approach at a run carrying shields in front of them and shouting as they come along, "pai! pai! pai!" They take up a position one behind the other with their backs to the Apulla brake and their faces turned towards the west from which direction the Wurtja's party is coming. As the latter approach the women begin to dance up and down the lines making with their right hands the movement of invitation and with their left hands holding their shields against their breasts. The Wurtja party approaches at a run, the Wurtja himself being concealed in the centre, each man carrying several pieces of bark which are thrown at the women while the men shout loudly, "Whirra!" and the women shield their faces. When close to the Apulla the men fire a final volley and the women run away, pell mell, their pace accelerated by the vehement shouting of the men who are standing about in all directions away from the Apulla to which they return as soon as the women have gone. The bushes are taken off the Wurtja by the Urinthantima and Okilia and he is told to remain in a crouching position.

The Apulla ground is now carefully cleaned and the Wurtja's brake shifted to within a few yards of the western end after which a council, in which Okilia, Oknia and Gammona take part, is held at the eastern end for the purpose of appointing a man to act as "Wulya," his duty being to paint a design upon the back of the Wurtja, the choice of the design resting with the Wulya who is supposed to choose one of those which are called "Ilkinia," that is a design belonging to a totem and emblematic of the latter. He is also supposed to choose one of a totem group of his own locality. During this conference two Okilia men have been sitting opposite to each other, and as soon as the choice has been made one of them smoothes the ground between them and then the other, who in this instance belonged to the same locality as the Wurtja, crosses over and sits down between the legs of the first man. Them a Gammona man of the Wurtja's locality steps out and brings back an old man who is Ipmunna to the Wurtja and upon whom the choice has fallen. He comes with well simulated reluctance as if he felt himself overpowered with the honour thus conferred upon him and sits down in front of the Okilias, the front one of whom takes up a boomerang and with much deliberation draws the flat side three times steadily along the ground making thus a smooth little trench out of which he scoops a little soil, and then shuffling along on his knees empties it into the hands of the Ipmunna man. Then he embraces him and rubs his forehead and face against the old man's stomach. Then the other Okilia, the Gammona and Oknia, in the order named, embrace the old man in the same way. The latter belongs to a northern locality, and in choosing him a well recognised compliment has been paid to the group to which he belongs. The old Atwia-twia who had previously been chosen to perform the operation of circumcision now comes up and holds a whispered conversation with the newly appointed Wulya saying that he is an old man, that his sight is failing and that he does not feel equal to the task, and asks that his son may be allowed to act in his stead. This is agreed to and then the son is called up, and after another whispered conversation on the subject the meeting breaks up and all the men begin to decorate themselves in various colours, the designs having no special significance. The two Atwia-twia are, however, prominently painted on the face, and their cheeks are blackened with charcoal.

After the Wurtja has been crouching at his brake for some time with his face turned towards the Apulla, the Wulya comes and begins to paint a design upon his back. The design in this instance is one associated with the Okranina (carpet snake) of a locality called Tharlinga, a northern locality, and represents a number of snakes around their hole which is indicated by a series of concentric circles.

The Wulya first of all rubs the body of the Wurtja all over with fat and then explains to the other men what he intends to draw after which he proceeds to work with great deliberation, more than an hour being spent over the drawing, while two old Ipmunna men keep up a low monotonous chant, the words of which have reference to the snakes (*i.e.* the ancestral snake-men) of Tharlinga. When the design is at last complete, an Okilia of the Wurtja's locality comes up and places two bunches of owl's feathers in his hair and then goes away and brings the Atwiatwia to inspect the design. The men who have previously made the Arachitta poles then run away from the Apulla shouting "pai! pai! pai!" and bring them in. When within about fifty yards of the Wurtja they separate into two parties, one of them crosses in front of the Wurtja from left to right and deposits their poles twenty yards to the right of him, while the others do the same on the left side. No explanation of this can be given except the usual one that it has always been thus in the Alcheringa.

Just before dusk two Okilias go out and stand, one on the eastern end of each of the raised banks, with their arms in a somewhat curious attitude, the palm of the hand being turned so that it faces backward, and the elbow bent so that the hand lies in the armpit. The Uranthantina man goes and sits down in the place usually occupied by the Wurtja when he is watching a ceremony while the other men, seated around him, sing—"Elunja apirra arara"—"hark to the lizards in the trees." At a signal from an old mūra man the women, who are waiting out of sight, come and stand in two groups one to the right and one to the left of the Apulla. It may be mentioned that in the grouping of the men and women there is no separation of those belonging to different classes. As soon as the women arrive, the two Okilias who are stationed on the banks run off to the Wurtja's brake and quickly tear away the bushes which hide him from view so that he is seen crouching down. One of the Okilias then kneels down on each side of him and at once the three men run quickly, on all fours, to the Apulla where the Wurtja lies down on top of the Urinthantima, who is himself lying down on his back, and the two remain in this position for about ten minutes. While this is taking place a woman who is

Mia to the Wurtja comes and sits down behind one of the Oknia and two others sit behind two other Oknia. At the same time the men who have brought in the Arachitta poles and are about to wear these attached to their legs are busily engaged, with the assistance of other men and some of the women, in fastening them on. At the end of the ten minutes the Urinthantima wriggles out from underneath the Wurtja who remains lying, face downwards, on the ground. The old Ipmunna stands close by explaining the design on the back of the Wurtja, and after a time calls up two women who are Ipmunna to the Wurtja to come and rub out the design; they come forward reluctantly, and one after the other stoop down and with their foreheads efface the drawing. The men with the Arachitta poles are now ready and come on to the Apulla. Dancing and singing begin at once, the men carrying the poles attached to their ankles run up and between the banks of the Apulla, while the women follow them about stripping the poles of their leaves. It is now dark, and the only light is that given out by a big fire which has been made by heaping the two brakes on top of one another and then setting fire to the whole mass. The Wurtja looking on sits between the legs of an Okilia, and the scene is one, as can be imagined, of the weirdest description. Suddenly the old mūra man gives out a great roar, whereupon the dancing ceases and the women quickly run off, followed by menacing shouts from the men. At the same time the sound of bullroarers is heard coming from each side of the Apulla, and at this signal the Wurtja is laid down on his back and some of the Oknia and Okilia men taking up a number of the Arachitta poles stack them on top of him, and, lifting them up and down as if beating time with them on his body, they all sing wildly—

"Ingwa alkirna alkirnie li
Urtnathie alkirlie impara."

Ingwa means night or darkness; Alkirna, twilight; Alkirnie li, a great clear light; Urtnanthie, a lot of trees growing close together; Alkirlie, like the sky; Impara, rising red like the sun.

The fire is now giving out a brilliant light and the two Atwia-twia men take up a position close to it at the spot marked D on the diagram. With their beards thrust into their mouths, their legs widely extended, and their arms stretched forwards the two men stand perfectly still, the actual operator in front and his assistant pressing close up behind him so that their bodies are in contact with each other. The front man holds in his extended right hand the small flint knife with which the operation is to be performed and as soon as they are in position the Ikuntira man who is to act as shield bearer comes down the lines carrying the shield on his head and at the same time snapping the thumb and first finger of each hand. Then, facing the fire, he kneels on one knee, just a little in front of the operator who stands perfectly still. During this time the bullroarers are sounding all round so that they can be heard far away by the women in their camp, and by them it is supposed that the roaring sound is the voice of the great spirit Twanyirika who has come to take the boy away.

The Arachitta poles are now quickly snatched from the top of the body of the Wurtja, and he is at once lifted up by Okilia men who run, carrying him feet foremost, and place him on the shield. Then in deep, loud tones the Lartna song is sung, indeed almost thundered out, by the men :—

"Irrie yulta yulta rai
Ul katchera ul katch ar-arai
Irri yulta yulta rai
Ul katchera ul katch ai."

The assisting Atwia-twia at once grasps the fore-skin, pulls it out as far as possible and the operator cuts it off and immediately along with all the officials of the ceremony retires out of the lighted area, while the boy is stood up and held by Oknia and Okilia who say to him, "you have done well, you have not cried out." Then he is led back to the old brake where he receives the congratulations of the men, and, at the same time, the blood from the wound is allowed to flow into a shield which is given to him by a young Oknia man to whom afterwards he will have to give food just as he does to his own father.

While he is still bleeding an Okilia man brings up some of the bullroarers and pressing them upon the wound tells him that it was these which made the sound and not Twanyirika, that they are sacred Churinga and must never be shown, or even mentioned, to the women. To this the boy listens in silence. When the bleeding has diminished he is led to the eastern end of the Apulla where he stands, between two Okilia, looking towards the west while two other Okilia, taking each an Arachitta pole, mount the bank and holding their poles over the middle of the path shout loudly, moving them up and down as they do so, "Arara, arara, arara," which is the signal for the officials to return, which they do, coming up one at a time. As each man comes up the Okilia shouts, "this is Wulya (and so on through the list), do not mention his name," and then each of them embraces the boy in turn, pressing their bodies closely together. As each man comes up, and the presentation is made, the same ceremony is gone through and in turn every one of those who have taken any special part is named by the Okilia whose cry, "Arara. arara, arara," rings out sharply in the darkness, for the fire is now burnt down. When the presentations are over the Okilia produces a bundle of Churinga saying, "here is Twanyirika of which you have heard so much, they are Churinga and will help to heal you quickly, guard them well and do not loose them or you and your mothers and sisters will be killed, do not let them out of your sight or you and your mothers and sisters will be killed, do not let your mothers and sisters see you, obey your Okilia who will go with you, do not eat forbidden meat."[1]

The newly made Arakurta then remains for some time standing by a fire, the smoke of which passes over his wound. Finally he is taken away by a special man in whose charge he has to remain until his wound is healed, when the ceremony of Arilthia will be performed. This man is, if one be available, an unmarried umbirna to whom the boy's sister has been promised. Failing such an one he may be an Oknia, Okilia or a Mūra man.

There are certain restrictions and customs which must be strictly observed by the more immediate blood relations of the boy which may be here noticed, as they will serve to show still more clearly the importance which is attached in the native mind to the initiation ceremonies. From the time of the handing of the firesticks until the recovery from the subsequent operation of ariltha the Mia must have no intercourse with the father of the boy until the whole proceedings are at an end. Any breach of this rule would result in the Arakurta growing up into "Ertwa akūrna"—a bad man or "Atna-arpinta," that is too much given to sexual pleasures, while strict observance will ensure his growing up "Ertwa mŭra" or a good man (using the words good and bad in the native sense).

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[1] In the particular ceremony now described, as soon as these instructions had been given to him a man brought on to the ground two young Arakurta who had been operated upon six or seven weeks before. They at once knelt down with their backs to the newly made Arakurta and he, acting on instructions from an Okilia, took a Churinga from his bundle and holding it in both hands, scraped their backs. This is called, "Untungalirrima" and places all three of the Arakurta upon the same footing and makes them friends. The two kneeling Arakurta were then told to go away quickly to their camp. This, of course, does not take place always, but only when two operations have followed closely upon one another.

After presentation of the firestick and until Lartna has been performed the Mūra tūalcha woman (that is the future mother-in-law of the boy) is "ekirinja" that is tabu, to the actual Mia of the latter. When Lartna has been performed the Mūra tūalcha woman goes to the camp of the Mia, and approaching her behind, rubs her all over with red ochre, and the Mia hands to the other woman a pitchi full of seed and in this way the tabu is removed.

While the Arakurta is out in the bush the Mia may not eat opossum or the large lace lizard, or carpet snake, nor any fat, as otherwise she will retard her son's recovery.

Every day she greases her "yam" sticks and never allows them out of her sight; at night time she sleeps with them close to her head. No one is allowed to touch them. Every day she is most careful to rub her body with grease and red ochre which in some way is supposed to help her son's recovery.

After the operation of Lartna the fore-skin is handed over to the boy's Okilia—the oldest one present—who also takes charge of the shield in the haft of which the blood has been collected. The piece of skin is greased by the Okilia and given to a young man who is Witia (younger brother) of the Arakurta and he is told to swallow it, the idea being that it will strengthen him and cause him to grow tall and strong. The shield is taken by the Okilia to his camp where he hands it over to his Unawa or wife who rubs the blood over the breasts and foreheads of women who are Mia Alkulla (that is elder sisters of the boy's actual mother) and Ungaraitcha (elder sisters) of the boy. These women must not on any account touch the blood with their hands, and after it has been rubbed on them the women adds a coating of red ochre. The actual Mia of the Arakurta is never allowed to see the blood.

When the Arakurta is out in the bush the men go and visit him occasionally and on these occasions he has to undergo a painful rite called "Koperta kakuma" or head biting. He is placed lying face downwards, men of all classes sitting round him singing about the biting of the head of the Arakurta and urging the biters to bite deeply. The men who are to do the biting and who may be of any class and are usually from two to five in number are chosen, on each occasion on which the operation is carried out, by the eldest Okilia of the youth. Their duty is to bite the boy's scalp as hard as they can and until blood flows freely, the patient often howling with pain. Each man may content himself with one bite or he may bite two or even three times. The object of this really painful operation is, so they say, to promote the growth of hair and at times the chin may be bitten as well as the scalp.

The Ceremony of Subincision.

As a general rule there is an interval of between five and six weeks between the ceremony of Lartna and that of Ariltha, but at times it may be even longer and it depends upon the time occupied by the recovery of the boy from the effects of the first operation.

The particular ceremony which is now described took place when the operation was performed upon two Arakurta one of whom belonged to the Purula and the other to the Kumara class, and was carried out in the northern part of the tribe. It must always be remembered that the details of all the ceremonies vary to a certain extent in different parts of the tribe, though the essential features are similar.

When the ceremony is to take place the men assemble at the spot where the two boys have been camped after the operation of Lartna. The boys are under the charge of an Okilia, who tells them to lie flat down upon the ground, and covers over their heads, all the young men who are of the same classes as the two Arakurta also lying down. The men of the Panunga and Bultharra classes sing about the marching of the Achilpa or "wild cat" men in the Alcheringa. During the night, first of all, a quabarra dealing with the doings of certain Achilpa men and afterwards one concerned with the Emu totem are performed by men who are specially concerned with them. These performances are, as usual, explained to the Arakurta, who are once more cautioned against ever telling any woman what they have seen and heard; they are now also told that the Quabarra belong to men of particular local groups who alone have the right to perform them. Then they are made to lie down again and the old men go away to a brake of boughs which has been built at a distance of about fifty yards and here they begin to sing songs concerned with certain totems such as the Quirra or Bandicoot. During the previous day an old Panunga man has made a special pole which is called a "Nurtunja" and which consists of a large spear ensheated with human hair string and decorated with rings of bird's down. In addition a small number of Churinga are hung on to it. The old man who has made it is Unkulla of one of the youths and Gammona of the other, and he has been asked by the Oknia and Okilia of the two boys to make the sacred pole. He has at the same time been asked to perform a ceremony, and at day-break the two Arakurta are brought from their camp to watch the performance. The old man carries the Nurtunja on his back and, sitting down on the ground, is another man who carries small bushes in his hands. The one with the Nurtunja represents a Quirra (bandicoot) man of the Alcheringa who is attempting to catch a woman and she is supposed to be warding him off with the bushes. The audience, including the two Arakurta, dance in front of and under the Nurtunja, and finally the old Quirra man fixes the pole upright in the ground and the Arakurta are told, as usual by Oknia and Okilia, to go and embrace the Nurtunja and while doing so are informed that they are about to undergo the rite of Ariltha, and that the embracing of the Nurtunja will prevent the operation from being painful. The Okilia now says, "who will be Tapunga?" Two men volunteer, one a Panunga and the other an Ungalla. The former at once lies down on his stomach and the latter gets on top of him, the two lying at the foot of the

Nurtunja. Then the Kumara Arakurta is laid down on them and a man sits straddle-legged over his body, while the operation is at once performed by an Uknaria man who is Ikuntira of the Arakurta. The actual operation which is performed with a stone knife only occupies a very short time, and consists, as has often been described, in slitting up more or less completely the penile urethra. As soon as the first Arakurta has been operated upon the second one is led up, placed on top of the same Tapunga men and quickly operated on. Then they are taken to one side and the blood which flows from their wounds is allowed to drain into shields on which they squat. They are now no longer Arakurta but Ertwa-kurka or initiated men.

When the Arakurta is seized for the purpose of having the rite of Ariltha performed on him the men set up a loud and prolonged shout of "pirr-rr" which can be heard by the women at the camp. They at once assemble at the Erlukwirra, that is the women's camp, and the Mia of the boy cuts the Unchalkulkna woman across the stomach and shoulders and then makes similar cuts upon women who are the boy's mura, elder and younger sisters, as well as upon those who are her own elder sisters. While making the cuts she imitates the sound made by the Ariltha party. These particular cuts which usually leave a definite series of cicatrices are called "urpma" and are often represented by definite lines on certain of the Churinga.

It very often happens that as soon as the operation on an Arakurta has been performed one or more of the younger men present, but who have been operated on before, stand up and voluntarily undergo a second ariltha operation. In such cases the men do not consider that the incision has been carried far enough. Standing out on the clear space upon which the Arakurta has been operated upon, with legs wide apart and hands behind his back, the man shouts out "Mura ariltha atnartinja yinga aritchika pitchi"—"Mura mine, come and cut my ariltha down to the root." Then one mura man comes and pinions him behind while another mura man comes up in front and seizing the penis, first of all cuts out an oval-shaped piece of skin which he throws away, and then extends the split to the root. Most men undergo the second operation, and some come forward a third time, though a man is often as old as thirty or thirty-five before he submits to this second operation which is called "ariltha erlitha atnartinja."

The boy carries the Churinga about with him until he has completely recovered. When this is announced by the man in charge of him the men all assemble out in the bush and the Oknia and Okilia, after consultation, appoint a man to act as what is called "Irkoa-artha." It is his duty to remove all the decorations from the body of the Ertwa-kurka, after which has been done the youth is told to lie down on his face while the men sing a chant which is supposed to promote the growth of his hair, and he is told that he must not speak to the "Irkoa-artha" until some time has elapsed, and not then before he has made a present of food, which is called Chauarilya, to the individual in question.

When this has been done the men and the Ertwa-kurka assemble at some little distance from the main camp and begin to sing in loud tones—

"Chuk-ur-rokerai yaa li chaakaa-a
Yaama kank waa-a
Inkwurkna inkwurkna atnai
Inkwurkna inkwurkna atnai."

The lubras hearing the singing assemble near the main camp and begin to dance as they did at the Apulla. The song of the men ceases as soon as they approach the lubras, and at a distance of about fifty yards they halt, shouting "tirra, tirra, tirra," a sound which resembles that of whirling bullroarers, and which is taken up by the lubras. The young Ertwa-kurka, who is now completely undecorated, steps out from the men, runs close up to the dancing women and suddenly wheels round and runs off into the bush where he is followed by a number of men who camp with him for the night, during which, without the performance of any special ceremony, singing is kept up. Before day-break the Ertwa-kurka is dressed up by Okilia and Umbirna with all the ornaments such as forehead band, arm strings, tufts of alpita tail tips, etc., such as are worn by a native beau. He is also provided with a shield and spear-thrower, and at daylight the party starts for the main camp, the young man walking in the centre by the side of his "Irkoa-artha" while all shout loudly "tirra, tirra, tirra." When within about fifty yards of the women who are dancing and shouting as before, the men stop and the "Irkoa-artha" leads the Ertwa-kurka out but only accompanies him for a few yards, after which he goes on alone carrying his shield in front of him so as to hide his face, and when close to the women one or two Ungaraitcha (elder sisters) who are in the lead carrying pitchis (all the other women carry tufts of alpita in their hands), throw the pitchis at his shield and then press their hands on his shoulders from behind and also rub their faces on his back, after which they cut off some locks of his hair which they afterwards use to make up into hair-string ornaments for themselves. This ceremony is called "Anainthalilima," and after it is over the Ertwa-kurka is free to go into the presence of the various officials who have taken a special part in the ceremonies, though he must not speak to or of them, nor must he speak loudly in their presence for some months to come.

The ceremonies concerned with this part of the proceedings vary considerably in different parts of the tribe. In the south for example the young Ertwa-kurka is always shown a sacred ceremony of the "Akirra" or owl totem, on the night preceding the one on which he meets the women.

At daylight on the morning of the next day the men provide themselves with firesticks, and surrounding the young man conduct him to the lubras who are again waiting to receive him. The young man is fully decorated amd carries a shield and boomerang and some twigs of Eremophila. When the party is within a short distance of the lubras the men throw down their firesticks and halt, and the young man steps out from the centre of the group and throws his boomerang high up in the direction of the spot at which his mother was supposed to have lived in the Alcheringa.[1] Then he is led forwards by the

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[1] This throwing of the boomerang in the direction of the mother's Alcheringa camp occurs during the performance of other ceremonies such, for example, as those which accompany the knocking out of teeth in eastern groups of the Arunta tribe, and also in the Ilpira tribe, and may be regarded as intended to symbolize the idea that the young man is entering upon manhood and passing out of the control of the women and into the ranks of the men. The fact that he is using the boomerang is indicative of this and his throwing it towards his mother's camp is an intimation to her of the fact that he is passing away from her control.

"Irkao-artha" man, holding his shield before his face, and is placed squatting upon a fire which has been smothered with green leaves which the lubras have prepared, and behind which they stand, shouting "tirra, tirra, tirra," and making with their hands the movement of invitation already referred to. The Ertwa-kurka is then pressed down gently on the fire by the women, and after remaining in this position for a few minutes is taken off by the "Irkoa-artha" man, and handed over to a few young boys who have not yet been initiated, and who are told to camp with him but on no account to speak to him. After three days during which he speaks to no one, men who are his Okilia come out from the Ungunja and invite him to come and join them after which he becomes a permanent member of the Ungunja or men's camp. Before, however, he may speak to any of the officals who took part in the ceremony he has to go out into the bush and procure game as an offering to each one of them—this gift being called "Chauarilya."

At the presentation of "Chauarilya" the man to whom it is presented always performs some sacred ceremony, after which the mouth of the Arakurta and of all those who are present is touched with some sacred object which has been used in the ceremony, such as a Nurtunja, and in this way the ban of silence is removed. When these ceremonies have been passed through the native is regarded as an initiated member of the tribe and may take part in all the sacred ceremonies of his group, though it is not until he has passed through the Engwurra that he becomes what is called Urliara or a fully developed man.

The following names indicating the different grades of initiation are applied to the boy, youth and man at the times indicated:

(1). *Ambaquerka*, up to the time of throwing up.
(2). *Ulpmerka*, after throwing up and until circumcision is performed.
(3). *Arakurta*, after circumcision and before subincision is performed.
(4). *Ertwa-kurka*, after subincision and until he has passed through the Engwurra.
(5). *Urliara*, after the Engwurra has been passed through.

ART. XVII.—*Stylasteridæ from the Victorian Tertiaries.*

BY T. S. HALL, M.A.

(Demonstrator and Assistant-Lecturer in Biology in the University of Melbourne).

[Read 11th November, 1897.]

In a previous volume of the Proceedings I noted the presence of Stylasteridæ in our tertiaries, and described two new genera and species.[1] One of these *Leptobothrus spenceri*, as pointed out by the late Dr. P. H. Macgillivray,[2] proves to be a polyzoon, *Porina gracilis*. Of the other form, numerous examples have now occurred to me, and are dealt with below. The presence of two other genera, *Distichopora* and *Sporadopora* is noted, the latter being represented by what appears to be the recent species *S. dichotoma*.

DEONTOPORA, T. S. Hall.

This genus was founded on a single well preserved specimen.[3] Since then several other examples from our Eocene beds have come under my notice, and I obtained a very large number from the Miocene sands of the Grange Burn near Hamilton. An examination of these specimens throws some additional light on the structure of the corallum and on the affinities of the genus.

In the younger parts of the branches the cyclosystems are arranged in such a way that a zigzag form is produced, but this feature soon disappears with advancing age. The terminal cyclosystem of a branch, from which the succeeding systems are produced, has the dactylopores arranged in a complete ring round the gastropore, and the same character may be found in one, or perhaps two, of the next older systems. As growth proceeds, however, the dactylopores on the inner side of the system always disappear, and at a still later date the systems may be seen to be almost entirely obliterated. The gastropores are provided with styles, which are short and stout, and in the dactylopores a style is represented by a toothed plate on the outer wall. Within the gastropore, about the level of the top of the style, is a ring of projecting teeth, which thus divide the chamber into two portions an inner and an outer. In some of the specimens, ampullæ are very numerous. In one example for instance there was a row of five confluent ones on one face and four on the opposite face, while in another instance there were several, perhaps half a dozen, so massed together that they could not be clearly separated. The outer walls of the ampullæ are very thin and liable to be broken down. In the unbroken ones there is to be seen, in some cases, a fairly definite opening leading into the interior. The edges of these openings are rounded off so that they do not appear to be due to fractures. They occupy the places, in some cases at any rate, of the slit-like pores of the external surface and from which they are probably developed. Reference was made to this character in the previous paper and it was inferred that the definite nature of the opening implied a constant succession of escaping planulæ. The inner basal wall of the ampulla generally shows a large pore about its centre.

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[1] Proc. Roy. Soc. Vict., v., N.S., 1893, p. 117.

[2] Trans. Roy. Soc. Vict., iv., 1895, p. 103.

[3] Proc. Roy. Soc. Vict., v., N.S., 1893, p. 117.

In some well preserved specimens the cord-like ridges of the surface were seen to be crossed by fine ridges or striæ.

Anastomosis of two branches was noted in one instance, while in some others the corallum had almost entirely wrapped round a stem of *Isis*, which it crossed diagonally.

A series of measurements of *Deontopora* was made and compared with a corresponding series of *Stylaster* sp., which show that the cyclosystems and pores of the fossil are considerably larger than those of the recent form.

The diameters are as follows, the figures being millimeters.

	Cyclosystem.		Gastropore.		Dactylopore.
Deontopora - -	1·0 to 0·8	...	0·5 to 0·2	...	0·14 to 0·07
Stylaster - -	0·6 to 0·5	...	0·3 to 0·2	...	0·07 to 0·05

In the original description the affinities of the genus were left undecided. It will be seen that the relationship to *Stylaster* is very close, but the characteristic feature on which the genus was founded, namely the absence of dactylopores from the inner side of the cyclosystem, is so constant, except in the tips of the growing branches, that the retention of the genus appears advisable.

Localities. Eocene: Orphanage Hill, Fyansford; Filter Quarries, Batesford; Cape Otway; Clifton Bank, Muddy Creek. *Miocene*: Grange Burn (Forsyth's), near Hamilton.

Genus SPORADOPORA, Moseley

Sporadopora dichotoma. Moseley.[1]

The fossil specimens do not seem separable from the recent species described by Moseley.

The specimens consist of fragments up to about an inch and a half in length. The stouter pieces are cylindrical and about as thick as one's little finger, while those from nearer the distal end are elongate oval in transverse section and give out flattened lobes, just as shown in Moseley's figure.[2] The surface of the corallum is marked by short almost vermiculate lines which are merely the outer extremities of the irregular branching, and anastomosing calcareous bars, of which the whole corallum is built up. The structure is denser nearer to the surface than in the axial portions as shown both in thin sections and in the broken ends of the branches. Piercing the outer wall are a great number of circular pores varying greatly in size, and scattered irregularly over the surface. The gastropores, as also the dactylopores, are of several sizes, and viewed externally are, as a rule, choked with the clayey matrix in which they were found. Frequently the gastropores are plugged with a grain of siliceous sand, which is at times disastrous when a slice is being ground down. The varying size of the gastropores is not mentioned by Moseley in the text but is shown clearly in one of his figures.[3] It is rather difficult to arrive at any exact proportion of the number of gastropores to that of dactylopores, as the latter, being smaller, are more hidden by the matrix, which even several boilings in carbonate of soda has failed to remove. The broken ends of the better preserved specimens show the gastropore styles with great clearness. As a rule the specimens are not infiltrated by any foreign matter, excepting close to the outside, so that the delicate tubulæ and complicated styles can be seen as clearly as in a recent specimen. The gastropores can be seen to open at right angles to the general surface of the corallum and the canal then to curve down towards the proximal end, running parallel to the axis.

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[1] Phil. Trans., 1878, p. 429.

[2] *Loc. cit.*, pl. 34, fig. 1.

[3] *Loc. cit.*, pl. 35., fig. 2.

The general appearance agrees exactly with the figure of the section given by Moseley, but I have not seen any ampullæ. The dactylopores are not so constant in their course as the gastropores, but seem to rapidly disappear in the ground meshwork. The perforations in the pore-walls are plainly visible.

Some of the larger portions are bored by some organism, which, finding the axial part less dense, has occupied this part of the corallum. Some of these tubes have a thin calcareous wall of their own. After a prolonged examination I have been unable to detect any criteria which would separate the present fossils from the forms described by Moseley. The "Challenger" specimens were dredged off the mouth of the Rio de la Plata in 600 fathoms.

Locality. The present specimens I gathered in the Miocene clays of the Grange Burn, Section II^{D}, Allotment I., Parish of South Hamilton.

This genus, as represented by a new species *S. marginata*, T. Wds., is recorded by Tenison Woods from the Eocene of the Chatham Islands.[1]

DISTICHOPORA, Lamarck.

The careful way in which the morphology of this genus was worked out by Moseley[2] leaves very little to be desired. With regard to the specific characters that distinguish the different members of the group considerable difficulty arises. Tenison Woods[3] gives a detailed account of five species known to him from the Pacific. More recently Professor Sydney J. Hickson, dealing with a collection made in Torres Strait by Professor A. C. Haddon[4] arrives at the conclusion that the characters hitherto relied on in the main as specific are not so in reality. He is inclined to believe that the colour variation is merely an indication of sex and age, and says "In all cases it is difficult to determine specific differences in Hydrocorallines; but the difficulty is considerably increased when there are only small pieces of the coralla at the disposal of the naturalist, for the general form, colour and mode of branching of the entire colony have always been taken as some of the most important specific characters of these corals, and these features cannot be determined by the examination of small pieces. Whether these characters are satisfactory is another matter." These difficulties press the more heavily upon the palæontologist, as he has usually to deal with very small fragments.

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[1] Palæontology of New Zealand, pt. iv., 1880, p. 22.

[2] *Loc. cit.*

[3] Journal Roy. Soc. New South Wales, 1879.

[4] Scientific Proc. Roy. Dublin Soc., vii., N.S., pt. v.

Numerous fragments of the genus have occurred to me from both our Miocene and Eocene beds, but I leave their specific determination undecided. A series of measurements of the diameters of the pores showed that the range of variation was so great that satisfactory results could not be attained in this way. Comparison was made with a recent specimen of *D. coccinea*, Gray. The pores as a rule were larger in the fossil than in the recent form. In many of the specimens, which were somewhat rolled and corroded, the thinner tissue near the mouth of the pores had broken down so that the gastropores appeared to open into a longitudinal sulcus while the dactylopores occupied grooves leading into this and also trenching the outer wall of the corallum. For some time I thought that this might serve as a specific difference, but as most of the specimens showing it seemed to be worn, and were moreover small and presumably young branches, whereas the characters did not appear in thicker specimens, stress cannot be laid upon it. Still I think it very probable that better specimens will show that the peculiarity of the dactylopores opening into grooves does normally occur in our Eocene species. Till specific differences are found in the corallum of the recent species which are decipherable even in fragments, we must, I think, rest content with a generic record from our tertiary beds.

Localities.—Miocene: Grange Burn, near Hamilton; *Eocene*: Muddy Creek; Batesford.

ART. XVIII.—*The Geology of Coimadai.*

PART II.

THE SILURIAN AND GLACIAL BEDS.

By GRAHAM OFFICER, B.Sc., and EVELYN G. HOGG, M.A.

With Appendices by C. W. DE VIS, M.A., *and* T. S. HALL, M.A., *on the Marsupial Bones of the Coimadai Limestone and the Graptolites of the District respectively.*

(With Plates VIII. and IX.).

[Read 11th November, 1897].

As stated in Part I. of the present paper a short account of the glacial beds of Coimadai was communicated by us in conjunction with Mr. L. J. Balfour, B.A., to the A.A.A.S. at its Brisbane meeting in January, 1895. Since that time we have had opportunity for studying in detail the geology of the district, and though further acquaintance has led us to modify our opinions in minor details, it has on the whole confirmed the conclusions at which we had then arrived.

The Lower Silurian beds which form the base of the series exposed in the district consist mostly of sandstone, fine- and coarse-grained, slates and shales: they are highly inclined throughout the area and maintain a fairly constant strike of N. 10° E. The only fossils met with in the district are Graptolites, a description of which has been kindly communicated to us by Mr. T. S. Hall, M.A., for which see Appendix B.

In a section of the Silurian exposed in the Pyrete Creek, near Wightman's farm, a thin bed of conglomerate is intercalated between coarse grained sandstones; the included pebbles consist of well-rounded white quartz and the matrix is made up of quartz grains. The bed is lenticular in shape and rapidly thins out at either end; its length is about 20 feet, and its greatest thickness not more than eight inches; it is the only bed of its kind known to us in the district.

Permo-Carboniferous Glacial Beds. Under this name we have grouped a series of beds occurring in the district which are either of undoubted glacial origin or bear evidence that during their formation glacial conditions supervened. They are mainly developed in the western part of the district between the Goodman's Creek and Lerderderg River, many excellent sections being exposed in these streams; along the Pyrete and Back Creeks, and in the area north of Coimaidai drained by Basin Creek. In the absence of outcrops the nature of the subjacent glacial beds may be in many places plainly inferred from the profusion of striated boulders scattered over the surface of the ground.

In our division and nomenclature of the glacial beds we adhere to the plan adopted in our Brisbane paper, and classify them as follows :—

(1) Stratified mudstones.
(2) Glacial conglomerates.
(3) Stratified sandstones and freestones.

This terminology does not agree with that adopted by Professor David in his paper read before the Geological Society of London in February, 1896.[1] The beds which we call glacial conglomerates are apparently the same as his hard glacial mudstones; the beds he describes as conglomerates are so sparingly developed in the Coimaidai district as not to warrant a special division of the beds to include them. The beds which he calls clay-slates apparently correspond to our well stratified mudstones; we have observed no bed in our district to which the term slate can be properly applied.

Stratified mudstones. The beds are first described, as they form the lowest of the glacial series visible in our district. They consist of regularly stratified deposits of a more or less hard tenacious clay; they are occasionally finely laminated; they vary somewhat in colour, blue and yellow being the prevailing tints. Their glacial character is at once attested by the number of scored and scratched stones and boulders, varying from mere pebbles to huge rock-masses weighing tons, contained in them. The included stones and boulders are for the most part scattered irregularly through the matrix, but occasionally bands of these scored stones can be seen, as if they had been laid down on a level pavement, *e.g.*, sections near Elam's farm. The matrix is mainly argillaceous; it is usually fine-grained, but is in places from medium- to coarse-grained.

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[1] See Q.J.G.S., vol. lii., pt. ii., No. 206.

Glacial conglomerates. The second division of the glacial beds which we make we have, for want of a better term, called glacial conglomerates. These beds sometimes show an ill-defined stratification, but they very often appear to be quite unstratified. The matrix is very similar to that of the stratified mudstones, but the included scored stones are on the average somewhat smaller. The beds are usually of a purple colour where unweathered, and are extremely hard. The main difference between these beds and the mudstones is a question of stratification. It may here be mentioned that in both beds already described, irregular "nests" or patches of true conglomerate and coarse angular grit occur.

Stratified sandstones and freestones. These are well stratified beds forming the highest of the glacial series; they are developed only in the area between the Lerderderg River and Goodman's Creek, with the exception of a small outcrop on the E. of Goodman's Creek near its junction with Back Creek. They are quite similar in appearance to the Bacchus Marsh sandstones, and like them have been largely quarried for building purposes; they have yielded no fossil remains. They are often highly calcareous and sometimes contain magnesia. The frequent presence in these beds of erratics shows that the glacial conditions had not entirely passed away; it is worth noticing that these erratics are for the most part granite. They sometimes show current-bedding.

As the map of the district published herewith only shows the general distribution of the glacial series, it may be mentioned that the stratified mudstones are best exposed in the Goodman's Creek near and above Elam's farm, on the Lerderderg River, S.W. of this point, and on the Pyrete Creek, S. of the township of Coimaidai. The largest exposure of the conglomerate is in the S.W. part of our district, and of the sandstones at and south of the junction of Back and Goodman's Creeks, occupying the higher elevations.

Field observations. Starting at the S. end of Goodman's Creek, the glacial conglomerates extend northwards for several hundred yards. They present the usual characteristics of their class and show little or very indistinct traces of stratification. They merge upwards into sandstones and for a short distance dip in a north-easterly direction at a low angle. As we proceed further the dip fluctuates a good deal and at a point about a quarter-mile S. of Elam's farm it is apparently in a S.E. direction. This brings into view a series of beds, the lowest occuring in the district, which are exposed for about one and half miles up the creek. They are at first obscurely stratified: they consist of a blue coloured clay, and are less hard than the glacial conglomerates. Going further up the creek the stratification becomes more marked, and the beds become very rich in included boulders which are, generally speaking, much larger and more grooved here than elsewhere in the glacial series. Here occurs a small but well marked intercalated bed of boulders, which are much scored and show considerable uniformity in size and composition. A little beyond Elam's the beds have a slight dip to the N. Stratified mudstones continue up to the junction of the Back and Goodman's Creeks. At about quarter-mile below this junction a section is exposed about 140 feet in height; the beds composing it are somewhat scantily supplied with included boulders and stones. Here the mudstones pass upwards into the unstratified glacial conglomerates in which boulders are numerous though small; the conglomerates in turn pass upwards into sandstones, similar to the Bald Hill sandstones. This whole series dips a little E. of N. at an angle of from 10° to 20°. The sandstones cover a considerable part of this locality, a change of dip bringing the sandstone over to the E. bank of the creek at this point. North of the junction the Silurian rocks occur for the most part, but occasional patches of glacial beds may be seen.

The glacial beds are exposed along the Lerderderg River for about two miles above the point where the Goodman's Creek joins it. About a quarter of a mile above this point mudstones dipping to the S. and overlain by sandstones are seen, while at the big bend in the river a little further on sandstones and mudstones again occur. Beyond this blue well-stratified mudstones containing numerous scored boulders are encountered; they bear a strong resemblance to beds which occur on the Goodman's Creek, and they dip to the S. at about 10°. Mudstones are exposed on the opposite side of the river for a considerable distance, and finally at the sharp bend in the river close to the point at which it emerges from the ranges, an excellent section of the mudstone is exposed in a high bluff. This is apparently the section referred to by Daintree, and in our opinion the beds forming it are continuous with those composing the high bluff on Goodman's Creek previously referred to. Most of the area between the bluff on the Lerderderg River and the Back Creek is covered with glacial beds which are in places capped with tertiary formation.

On the Coimaidai side of the basaltic plateau glacial beds are exposed along the Pyrete Creek for a distance of about two miles southward from the township: they are mainly mudstones, some showing well-marked stratification, others little or none. Included boulders are numerous but somewhat small. No sandstones have been found in this part of the district. We are inclined to place the Pyrete beds on the same horizon as the upper mudstones of the Goodman's series. At the southern end of the Pyrete beds a considerable mass of glacial conglomerate occurs. The principal interest of the Pyrete beds lies in their association with the glaciated surfaces of the underlying Silurian rock, to which reference will presently be made.

Patches of glacial beds are found scattered over the broad valley drained by Basin Creek, to the N. of Coimaidai, but no good sections are exposed. Striated stone and foreign rock material are to be collected over a considerable area here.

Faults. At the N. end of the Goodman's Creek sections a good deal of faulting of limited extent has taken place. One of these we shall note as shown in section in one of the freestone quarries on the W. side of the creek. This has a throw of about 12 or 15 feet.

Another fault of greater importance occurs about half-way between here and Elam's farm. It is a compound fault, and is shown very distinctly, cutting through the lower mudstones of our series.

In this locality, owing to the softer nature of the lower stratified beds, a wide open alluvial flat stretches to the E. and across this flat, extending in an easterly direction, a more or less well marked ridge can be made out. This marks the course of the fault. The section exposed by the Creek shows the stratified mudstones to be suddenly interrupted by a mass of hard unstratified boulder-bearing mudstone, and about 20 yards or so in width. On the N. side it shows a very clean and decided wall at its junction with the stratified mudstones. On the S. side the junction is observed by recent alluvial and gravels, but doubtless the wall here is just as marked. It would appear that two parallel faults close together have occurred, and the mass between has been displaced. We are not in a position to state definitely whether this mass of rock moved downwards or upwards, but as the displaced bed corresponds very well in character to the second class of our division, we are much inclined to the opinion that it was a downward displacement, and probably does not amount to less than 50 feet. The harder material of the displaced mass has resisted weathering and denudation better than the softer stratified mudstones, and thus a ridge marks the course of the fault across the alluvial plain of the valley.

Dykes. A considerable number of dykes may be noticed penetrating the glacial beds exposed in the Goodman's Creek. Some are so decomposed that it is impossible to define their original character; those in a good state of preservation are composed of basalt, varying in structure from medium-grained to exceedingly close-grained. Several small ones occur in the vicinity of Elam's farm; close to the big fault just described there is a group of six or seven, while several small ones may be seen near the high bluff. They run more or less in an E. and W. direction, and are approximately parallel to the main joint planes which traverse the glacial beds in this locality. The occurrence of a bunch of dykes in close proximity to the fault alluded to above may indicate that the two phenomena are closely related. Similar dykes traverse the glacial beds exposed to the west on the Lerderderg River. We have nowhere observed a dyke passing through the over-lying tertiary beds, and it would thus appear that this system of dykes is not connected with the Bullengarook basalt which was poured out after the tertiary beds had been formed, but has arisen from some centre of igneous activity lying to the west of the district.

Rock material and erratics. The rock material found in the glacial beds is very abundant and of all kinds. Professor David in his Presidential address before A.A.A.S. remarks in his observations on the Korkuperrimul beds, that the bulk of the ground mass is of local origin, together with many of the boulders. Our observations, however, have led us to the conclusion that very few of the boulders are of local origin; some fragments of black slate quartz and quartzite may have been derived from local Silurian rocks, but the fact appears patent to us that the great bulk of the boulders is foreign. How far this is the case with the ground mass we hardly care to say, but we are inclined to think that a considerable portion of it is also foreign.

Another remark of Professor David's we are thoroughly in accord with, viz., the universal rounded and worn aspect of the boulders and pebbles, it being quite the exception to find an angular fragment.

A point to which we would also direct attention is that at certain horizons the boulders have a much greater average size than at others, besides being more numerous and more frequently and strongly glaciated. This can especially be observed in the sections of the blue mudstones on Goodman's Creek near Elam's farm. A section a little beyond Elam's shows a regular floor of boulders embedded in the mudstones. Just about here too occur the largest erratics we have found in the district. The following are particulars of a few of the best:—

(1) Hard sandstone, 6′ 6″ x 6′ x 3′ 6″.
(2) Quartzite, 4′ – 6″ x 4′ x 3′ – 6″.
(3) Granite, with large crystals of reddish felspar several inches in length, and well scored and grooved. Three years ago when we first discovered this erractic it measured 8′ – 3″ x 4′ – 5″ x 1′ – 10″. Mr. Elam informed us it was originally about 17 feet long.
(4) Granite similar to the last, and a little further down stream, about 10 feet in diameter.
(5) Hard blue quartzite, 8′ x 3′, partially exposed.
(6) Quartzite, 5′ x 4′ x 3′ – 6″.

Besides these many other boulders over 2 feet in diameter occur. One large fragment lying in the creek appears to have formed part of a glaciated surface, as the scored part is so well rounded, in contrast to the usual glaciated stone which is flattened where scored.

In the more unstratified mudstones the boulders and pebbles though numerous are as a rule small and well worn and show no trace of arrangement in the matrix, whereas in the stratified mudstones, as already remarked, a certain amount of arrangement is to be observed occasionally.

It is of importance to observe the more striking varieties of rock material among the boulders for the purpose of tracing their origin if possible. Many quartzites for example occurring in the drift would be difficult to trace to their source with any degree of certainty, but other kinds of rock may be of considerable value in this respect. Among such may be mentioned the various granites, gneiss, a felspar porphyry with a dark green ground mass containing red felspar crystals, certain quartz porphyries and a mica-diorite not unlike the Warburton trap rock. The granite most commonly met with is very coarse, some of the felspar crystals being several inches long. Besides the rocks above mentioned the included material consists of slate and quartz (probably derived from the local Silurian rocks) jasper, lydian-stone, greisen, conglomerate sandstone, grit and two blocks, one 18″ in diameter of marcasite, in a fine-grained quartzitic matrix. We have to thank Mr. Walcott, F.G.S., of the National Museum, for kindly examining this specimen.

During a visit to Springhurst, about two years ago, one of the authors observed several types of rock in the glacial drift there which we have not found in the Bacchus Marsh district. Among such may be mentioned a frequently occurring porphyry, with a slate-colored matrix, containing small crystals of quartz and a little felspar, a very red granite, and agatoid and jasperoid quartz. Boulders also of sandstone crammed with fossil casts of brachiopods, etc., are also frequent in this district. Mr. Etheridge, to whom one of these boulders was shown, said they might be Upper Silurian or Devonian.

We mention Springhurst in this connection as tending to show that certain kinds of rock may be confined more or less to a certain area, or indeed to certain horizons in the glacial series. And we would point out that the collection of the different kinds of rock material in the glacial beds with their position accurately marked, locally and in their proper horizon, would be a most valuable help in the unravelling of the glacial story.

Scored rock surfaces. One of the most striking features of the glacial geology of the district in the occurrence of scored rock surfaces and roches moutonnées. They are confined to the neighbourhood of the Pyrete Creek, and the exact positions of the better marked surfaces is indicated on the map. An exceedingly good example is seen on the Pyrete Creek about a mile below the bridge. The stream has here removed the glacial drift from the underlying hard Silurian sandstones, which now present the rounded and smooth appearance of typically glaciated rocks. These rocks, which extend for about 70 yards along the left bank of the stream, form two main masses, separated by an interval covered by alluvium, and for convenience in reference we have called them the "Pyrete Twins." In addition to the smoothed and rounded appearance may be noticed very distinct scorings and groovings, the general direction of which is from S.W. by W. to N.E. by E. Several hundred yards N.E. of the "Pyrete Twins" the Silurian again crops out at a higher level and exhibits a beautifully scored surface. There must have been at one time a considerable area of striated pavement exposed here, but unfortunately portions of it have been removed to furnish building stone for an adjacent cottage. The area remaining shows well marked grooves and striæ running in a S.W. to N.E. direction across a beautifully smoothed and polished surface. Both at this surface, which we have named "Wightman's Rock," and the "Pyrete Twins," the scorings correspond in direction neither with the strike nor the dip of the Silurian, but lie between the two. After very careful examination of these two instances we have no doubt that the glacier ice to which the scorings are due, came from the S.W. About a third of a mile further down the creek is a section showing the glacial conglomerate overlying the Silurian. The latter is again well scored and grooved, the direction being about N.E. In a small gully running parallel with the Melton Road, half a mile out of Coimaidai, another well scored surface can be seen, the direction of the groovings there being N. 35° E.

Numerous other examples occur in the district, but the above-mentioned are the best. Speaking in general, wherever the contact between the Silurian and the glacial beds can be seen, the former is scored and grooved in a manner that could only have been done in our opinion by a glacier or land ice-sheet moving from S.W. to N.E.

In several instances the direction of ice-flow is more easterly than this general course. In one case, in the valley of the Pyrete Creek, the scorings are about 75° E. of N. In another case, a scored surface occurring on the W. side of the Lerderderg, just outside the limit of our map, the direction is E. 10° N. We think it probable that the ice in the Coimaidai district travelled in a slightly more easterly direction than that in the Bacchus Marsh and Myrniong areas, owing to a certain local feature.

On looking at the accompanying map it will be seen that a little to the N. of Coimaidai, Silurian rocks outcrop in an E. and W. direction almost right across our area. At the time of glaciation this must have formed an escarpment or well marked ridge running transversely to the ice-flow, and probably causing a local deflection to the eastward.

Thickness and position of the Coimaidai series. The thickness of the glacial beds along the Goodman's Creek, shown in section along the line A B C of the accompanying map, is about 230 feet. Certain beds, however, outcrop on the Lerderderg River a short distance to the west of the mouth of Goodman's Creek, which probably lie above the ones shown in section, but owing to the manner in which the dip is masked by alluvium, we are unable as yet to prove the continuity of the beds and to determine their thickness. In any case we are inclined to regard the thickness given by us in our Brisbane paper as excessive.

Now, as the estimated thickness of the beds on the Korkuperrimul Creek is about 2000 feet, it is evident that we have only a portion of the series represented in the Coimaidai district, and it becomes a point of interest and importance to ascertain to what horizons in the larger section ours are to be relegated. We are, however, as yet unable to do this with any exactness.

The tripartite division of the glacial beds as indicated in our first paper on this district, is, as shown by Professor David, a notable feature of the Korkuperrimul Creek series, viz., stratified mudstones, unstratified mudstones or conglomerates, and sandstones. This association occurs again and again on the Korkuperrimul Creek. Gangamopteris occurs in sandstones at various horizons on the Korkuperrimul, but is most frequent in the uppermost sandstones at Bald Hill. So far we have not detected any fossils in our beds, and from this circumstance, and taking into account the dip and strike of the beds on the S. part of our area on the Lerderderg, we conclude that the Goodman's Creek series lie considerably below the Bald Hill sections, but are probably higher than the lowest on the Korkuperrimul.

Any theory of the conditions under which the glacial beds were formed has to satisfy two facts of prime importance, viz., the well-marked stratification of the mudstones and the foreign nature of the included material. Stratification is indeed not entirely absent from glacial deposits elsewhere exposed on the earth's surface, but it nowhere occurs either to the extent or perfection that it does in the beds of the Bacchus Marsh area. The large development of the stratified mudstones shows that in this district conditions prevailed during the glacial period which have been for the most part absent or entirely subsidiary in other glaciated areas. The theory which explains the formation of glacial beds elsewhere is inadequate here. As prime agents in the glaciation of the district we are limited to either icebergs or a land ice-sheet; either is a suitable vehicle for the transmission of material from one area to another; by means of either the presence of the foreign boulders in our beds may be explained, but in attempting to account for the stratification of the mudstones and the striation of the rock surfaces by means of icebergs grave difficulties present themselves; to these difficulties we have referred in the paper previously mentioned and do not propose to repeat them here.

In the present paper we ascribe the glaciation of the district mainly to a sheet of land ice which moved from the south; of the dimensions of this sheet but little can be said at present; it may have been and probably was continuous with the one to which we believe the glaciation of the Derrinal area is due, as the beds of this area bear a striking resemblance to those of the Bacchus Marsh area. The front of this ice-sheet terminated eventually in water; we are almost entirely in the dark as to whether this was marine or fresh; the little evidence furnished by the vegetable remains found in the Bacchus Marsh sandstones, and the total absence of any marine fossils point to a fresh-water lake. In this water were laid down the stratified mudstones and sandstones. We will first concern ourselves with the mudstones which form the lowest beds of the series in our district. From all glaciers terminating on the land sub-glacial streams issue, the water of these streams being derived from the melting of the glacier at its contact with the subjacent rocky bed, and at its upper surface exposed to the heat of the sun and atmosphere. That similar streams issue from a glacier whose front terminates in water there can be no doubt, as the same causes of melting are present in both cases. There has been but little opportunity afforded of studying the structure of beds formed from the sediment of sub-glacial streams discharging into a sea or lake, but reference will be made later on to the evidence brought to light in this matter at the Malaspina glacier. If a sub-glacial stream enter a sea or lake it will deposit the matter in suspension just as an ordinary stream does, that is to say, in stratified beds; this simple view of the matter does not account for the included stones in the mudstones. As stated before, we require that the glacier from which the sub-glacial streams issue should protrude into the lake or sea into which the streams empty. The existence of icebergs proves the possibility of a glacier advancing into the ocean, and the magnitude of icebergs shows that in cases the distance advanced through by the ice front before the berg is broken off is very considerable. Sir J. Ross records in his "Voyage of Discovery and Research in the Southern and Antartic Regions," that in many places the glaciers projected several miles into the sea. In investigating the physical relations of a glacier advancing into the sea, let us picture a mass of glacier ice, more or less loaded with included material, moving slowly down a moderate slope; the ice front would be pierced in places by the channels through which the sub-glacial streams issue; the lower part of the ice front would first reach the water, and would therefore be first subjected to melting by its contact with the water; as the forward movement continues the process of melting would result in the formation of an overhanging cliff of ice; any scouring action by the sub-glacial river would tend in the direction of wearing away the ice nearest to the bottom of the sea, and there would thus be a space more or less great according to circumstances between the lower side of the advanced ice and the bottom of the sea, and the sub-glacial streams would in consequence be unhindered in the distribution of their suspended matter. The disturbance and commotion which takes place when a berg is broken off and while it is seeking its position of equilibrium confirms the view just stated that between the ice-front and the sea bottom their exists a layer of water. In our view we must regard the sub-glacial streams as flowing for a longer or shorter period beneath the protruding ice-front; the matter held by them in suspension is being deposited in stratified beds beneath this tongue, which, as it slowly melts by its contact with the water, must drop the striated boulders, etc., it contains into the subjacent beds. If the ice-tongue continue to exist for a long time before the berg is broken off we should have a considerable profusion of included material in the beds beneath. With the separation of the berg mass from the parent tongue another set of conditions would arise; the formation of stratified beds by the sub-glacial streams would continue as before, but as the source of supply of striated stones, boulders, etc., has been removed by the floating away of the berg, the stratified beds should be almost entirely free from included matter, the only source of such material now being chance icebergs which might float over the site formerly occupied by the ice-tongue. In course of time the advance of a second tongue would lead to a repetition of the conditions favourable to the formation of stratified beds containing boulders, etc. In the sections along the Goodman's Creek we have both sets of beds displayed, the one rich in included material, the other destitute of it, but overlain by a second bed containing large quantities of boulders, etc. That a certain amount of the fine-grained material composing the stratified beds has melted out from the ice-tongue is probable; and though this would not interfere with the stratification of the beds, we are inclined to regard the sub-glacial streams as the principal agents in the formation of the stratified beds. It may also be pointed out that stratified beds with few included boulders might result during a climatic recession of the ice-front.

The evidence in regard to the formation of stratified glacial beds afforded by the Malaspina glacier is striking. This glacier, which is formed by the union of several ice-streams from Mount St. Elias, covers an area of 1500 square miles. In one place it comes down to the sea and terminates in cliffs sometimes 300 feet high. The lower part of the glacier is interrupted by two groups of hills, respectively named the Chaix and the Samovar Hills. They are described by Mr. J. C. Russell—who had charge of the exploration of the glacier in 1891—as "formed of a monoclinal block of conformable strata eight or ten miles long, trending N.E. and S.W., and tilted northward at an angle of 10 or 15 degrees. The general elevation of their crest is about 3000 feet. But what makes the hills especially interesting to the geologist is the fact that they are composed of stratified moranial material. The stratification is conspicuous even from a distance, but is due principally to slight differences of colour. Light purplish-brown alternating with light grey are the prevailing tints. The colours are in broad bands and may be traced continuously for thousands of feet. . . . . It is evident that the minimum thickness cannot be less than 4000 or 5000 feet. The rocks are essentially homogeneous from base to summit, and are composed of sandy clay containing large quantities of both angular and rounded boulders of all sizes up to 6 or 8 feet in diameter. The fact that they have been transported by glaciers is beyond question.

"In the finer portions of the deposit, especially in certain fine light grey sandy clays, sea shells are numerous. . . . . Besides the shells of molluscs there are shell cases of annelids (serpulæ?) attached to the glaciated boulders, showing that the stones on which they grew must have remained exposed at the bottom of the sea for some time before being wholly buried."

In the opinion of Mr. Russell, the Chaix and Samovar Hills were formed by the uplifting of the northern side of a fault or series of related faults.

Mr. Russell proceeds: "The interpretation of these various records leads to the conclusion that the strata composing the Chaix Hills were deposited about the extremity of a glacier which ended in the ocean. Portions of the finer material, especially that containing sea-shells, is largely glacial silt, while the boulders and gravel were deposited by the bergs that floated away from the face of the glacier. The deposit now forming at the extremity of the western lobe of the Malaspina glacier, where it breaks off into the sea, must be very similar to the strata forming these remarkable hills."

With this interpretation of the record we do not wholly agree; if the glacial silt was brought to the position it occupied prior to the uplifting of the beds by sub-glacial streams, it is not conceivable that the beds which were being formed from the sediments they carried should receive no boulders or gravel from the overlying stationary ice-sheet but only from those portions of the ice-front which had broken off and were presumably moving away from the area into which it is supposed they dropped the boulders, etc., they carried. The error has, we think, arisen from the assumption that a tongue of ice protruding into the sea is everywhere in contact with the sea-bottom beneath it, and this is an assumption that can only be upheld by showing that sub-glacial streams do not flow beneath a protruding tongue of ice and and is at variance with facts observed at the extremity of a glacier terminating on land. If the weight of the foremost parts of a land glacier can be sustained by the sides of the glacier valley and the columns of ice which separate the channels from which the ice-streams issue, it is entirely within the range of probability that when the glacier enters the sea and the force of buoyancy of the displaced water comes into play in the opposite direction to the weight of the mass that the advancing tongue will have contact with the sea-bottom only in places, and that there will exist channels which will permit of the flowing of the sub-glacial streams. These channels will change as the melting and scouring out of the ice continues, and this will permit of a wide and sometimes irregular distribution of the matter suspended in the streams and washed out of the ice. If the slope of the sea-bottom be sufficiently steep, the protruding ice-tongue may easily reach a point at which it requires no contact with the sea-bottom to support it, but is entirely upheld by the force of buoyancy arising from the displaced water; in this case there is no difficulty in accounting either for the stratification of the beds or the presence in them of included boulders.

There can be no doubt that the sandstones have been deposited in fairly deep calm water; false bedding is not entirely absent but in general uniformity of stratification is well maintained. The presence of erratics shows that the glacial conditions had not passed away, and that icebergs occasionally dropped their included material into the beds as they floated over. The general freedom of the beds from foreign matter, however, shows that either the icebergs were not very numerous or that they were but ill-supplied with included rocks and boulders. There is no evidence to show from what source the material composing the sandstones was derived ; any erratics they contain are similar in character to the boulders found elsewhere in the glacial beds.

The beds we have classed as conglomerates bear a general resemblance to the till or boulder clay of the glacial series of America and Europe ; and may represent the ground-moraine of the ice-sheet. The rude stratification they possess is very similar to that seen in certain of the glacial beds of America and Europe, but whilst the question of the origin of boulder clay or till is so contested a point among the glaciologists of Europe and America, we do not propose to enter into any detailed consideration of it. To each of the writers of the paper the appearance presented by the till of Great Britain is well known, and we are satisfied by observing that between the "till" and the beds classed by us as conglomerates, there is a strong general resemblance.

With regard to the formation of unstratified mudstones it may be pointed out that when a sub-glacial stream entered a lake where the separation of the ice from the bottom was very imperfect, the channel along which it flowed might speedily become gorged with sediment, forcing the stream to carve a new path through the ice. If the supply of sediment was great this might lead to the formation of beds showing little or no stratification ; but when the stream reached that position under the ice-front which would allow of the more gradual distribution of the sediment it carried stratification would begin to show. There would thus be a lateral passage or transition from unstratified to stratified beds—a feature often met with in the glacial series. There might also be a gradual transition from the true ground-moraine of the glacier into the sub-aqueous beds. Possibly the constriction of the channel occupied by the glacial stream may afford a clue to the explanation of the patches of water-worn gravel which, though present in the Coimaidai series, may be better observed in the Korkuperrimul Creek sections.

In conclusion it may be noticed that though the beds of the Coimaidai area show less complexity of structure than those exposed in the Korkuperrimul Creek, yet they must be regarded as part of the same series; similar general conditions probably prevailed over the whole Bacchus Marsh area, but in the country west of the Lerderderg River certain special conditions appear to have prevailed, the influence of which only partially, if at all, extended to the Coimaidai district. Their lacustrine origin under the action of an ice-sheet moving from the south is the feature common to all the beds, but the frequent occurrence on different horizon of boulder-beds separated by deposits of sandstone and conglomerate along the Korkuperrimul Creek points to a considerable variation of conditions during the gradual formation of the beds. The repetition of beds may be explained by climatic advances and recessions of the ice-front, and possibly in the area W. of the Lerderderg River there may have been considerable oscillations of level. Much evidence has been collected of late years to show that glaciers can move over loose and incoherent deposits without disturbing them, and Professor Geikie has ably argued that under certain conditions a glacier may cease to be erosive. Though a certain amount of contortion of the beds along the Korkuperrimul Creek has been noticed by Professor David, there is on the whole a striking absence of disturbance of the softer beds of the glacial series; an explanation of this feature may be found in the sub-aqueous formation of these beds.

EXPLANATION OF PLATES.

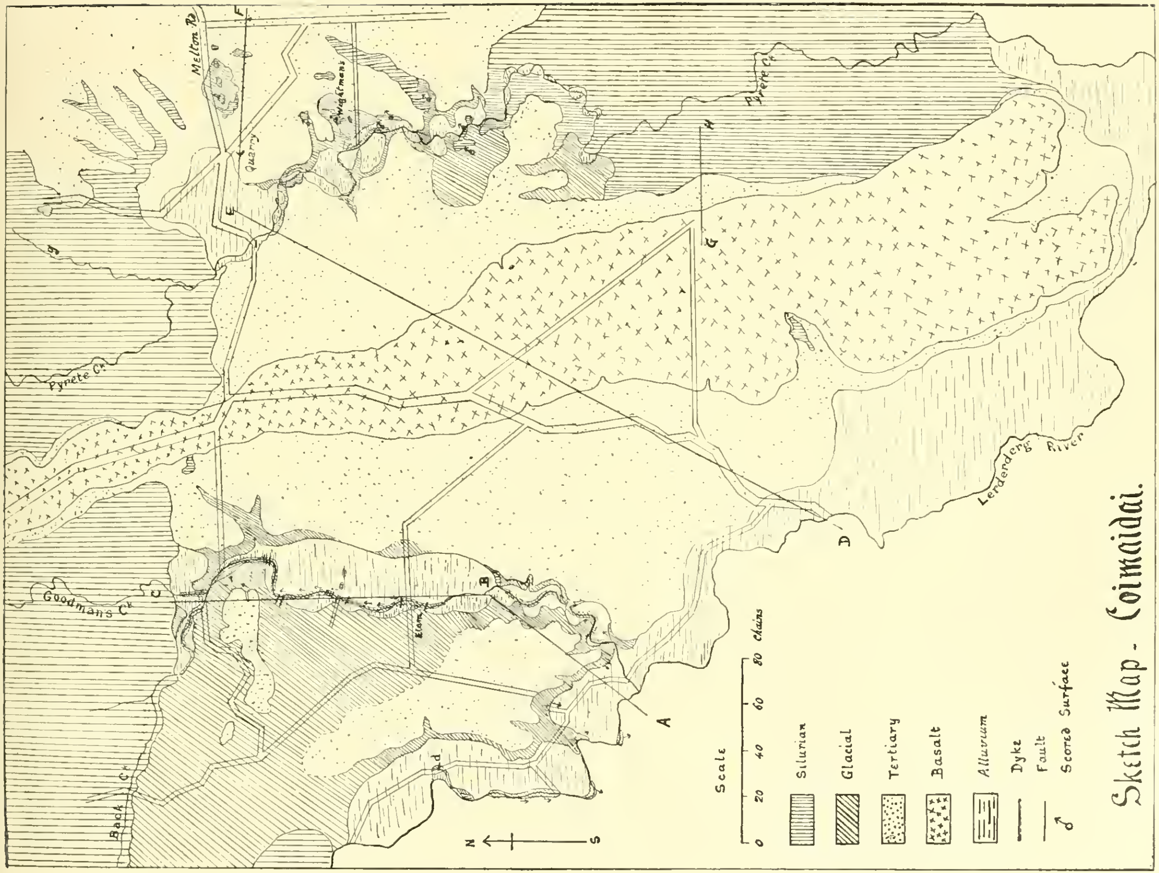
Plate VIII.

Sketch Map of Coimaidai.

Plate IX.

I.—Section through tertiary beds near Alkemade's Quarry.

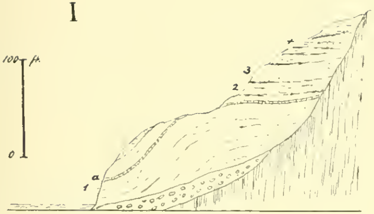
- (1) Magnesian limestone, with partings of clay and gravel, and containing fossil marsupial bones.
  - (*a*) Thin band of volcanic ash, interstratified with (1). The fossil bones occur below this.



Sketch Map - Coimadai.

Proc. R.S. Victoria, 1897. Plate IX.

I



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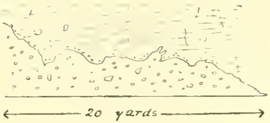

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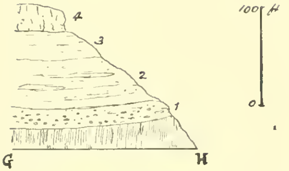

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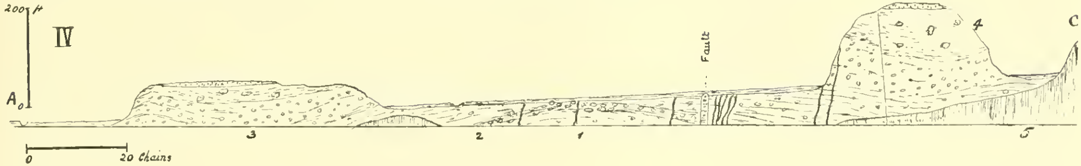

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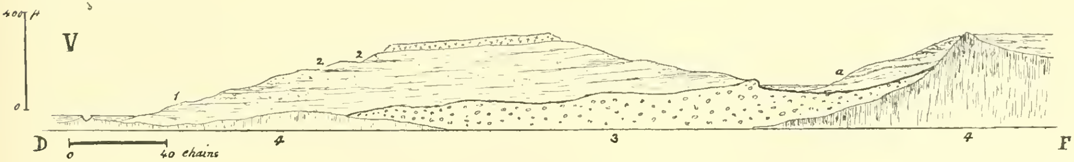

(2) Sand and gravel.
(3) Quartzite.
(4) Gravel, sand and ferruginous conglomerate.

The whole rest on Silurian and Glacial.

II.—Section at junction of Goodman's and Back Creeks, showing uneven (eroded?) junction of sandstone with glacial mudstone. A thin line of angular pebbles occurs along the junction.

III.—Section along GH on map.

(1) Hard cemented conglomerate and quartzite.
(2) Sand and gravel, with clay and lenticles of limestone.
(3) Magnesian limestone containing casts of Limnæa, etc.
(4) Basalt.

The whole lies on Silurian.

IV.—Section along ABC on map, showing the Goodman's Creek series of Glacial beds.

(1) Well stratified mudstones, in which occurs.
(2) Zone of large numerous and well scored boulders.
(3) More or less unstratified beds (glacial conglomerates) passing upwards into
(4) Sandstones containing occasional erratics.

The whole is capped by tertiary gravels and conglomerates, and is intersected by numerous basalt dykes.

V.—Section along DEF.

(1) Thin bed of pipe clay containing leaf impressions (Laurus Werribeensis) and interstratified with sand and gravel.
(2) Thin beds or lenticles of magnesian limestone.
(*a*) Thin bed of volcanic ash interstratified with limestone containing Marsupial bones.
(3) Glacial beds.
(4) Silurian.

The whole capped by basalt 30–40 feet.

APPENDIX A.

On the Marsupial Bones of the Coimaidai Limestone.

BY C. W. DE VIS, M.A.

Of the twenty-two fossil bones and moulds more or less occupied by bone, collected by Messrs. Officer and Hogg, and by Mr. Ferguson, of the Mines Department, from Alkemade's Quarry, Coimaidai, about two-thirds are capable of determination; they are three lower jaws, seven pieces of long bones, four bones represented by cavities in the matrix, and one metatarsal. With the valuable exception of one jaw, these relics cannot be said to have been fossilized in a manner favourable to identification, and the difficulty of dealing with them is in most cases increased by their imperfect condition prior to burial. Without exception they are mammalian and marsupial. They have been contributed by three families of the Marsupialia, the Phascolomyidæ, Macropodidæ, and Nototheriidæ, and consequently are examples of the Nototherian fauna of Tertiary or Post-Tertiary time. To take them in order, the first to attract notice is a member of the

Phascolomyidæ. Phascolomys parvus, Ow.

The validity of this species is confirmed by the fossil under view, the horizontal ramus of a right mandible in a fine state of preservation, the teeth (save for the absence of the crown of the incisor) being in perfect condition. Apart from its rarity the mandible has a strong claim on our interest, as it unmistakeably correlates the Victorian beds with the drifts of Southern Queensland, and by showing how extensive was the range of this little Wombat, prepares us to expect similar diffusiveness in other Marsupials contemporary with it.

Macropodidæ. Halmaturus dryas, mihi.

Mandibles. A horizontal ramus of an adult left mandible. Of the premolar the fangs in their sockets are all the remains; the crowns of M^1 and M^2 are much corroded; the anterior talon in M^3

and the hinder lobe of M^4 are broken away; the remaining portions of the last two teeth have lost their enamel, and their whole substance indeed appears to have been converted into pseudomorphs of the originals and their surface characters obscured by calcareous matter, but their general form remains sufficiently evident to show by their straight sharp ridges that they could only have belonged to a Halmaturus. The dental series in this jaw measures by estimate 40mm., the sockets 52·5, and the anterior depth of the mandible is 29mm. In size, therefore, as in general facies, it agrees fairly with *H. dryas*, and to that species it is provisionally referred. The identification is supported by the presence of a second but left mandible from an aged individual; in this all the teeth of the molar series are in place, but like the last so fragile, that an attempt to remove encrusting matrix had to be abandoned. Enough of the imperfect premolar, however, is visible to show the size and form of the tooth. From these and from the length of the true molars little doubt remains as to its identification with the same species as the preceding jaw.

Femora. No entire skeletons of extinct Macropods have as yet been found or at least described. In the large collection of their remains accessible to me there are indeed but one or two instances of bones and teeth found together under circumstances suggestive of their specific co-identity. All the species but one being founded on jaws, the attributions of bones to certain species which have been hitherto or are still made by authors, are therefore conjectural and at the best approximative. But since measurement enables us to refer every recognisable bone provisionally to one or two or three species, we may fairly allow our choice so limited to be guided by the extraneous conditions of the case. It should at the same time be remembered that identification by measurement proceeds on the assumption that the proportions of the animal in question were the same as those found in the living species taken as a base of comparison, an assumption which under the circumstances cannot be verified. Under the impression, however, that it is better to get as near as possible to accuracy, in spite of uncertainty, than to neglect enquiry because of uncertainty, I venture to attribute to this species the bones which seem to pertain to it. Among these are the distal end of a left femur wanting the outer condyle. The breadth of its shaft near junction with the epiphysis is 57mm., between the same points in the femur of *M. giganteus* the measurement is 46, in M. rufus 45. The mean length of the lower cheek teeth in these two largest of living Kangaroos (Queensland specimens) is 48mm. Proportionately, therefore, the molar series of the species examplified by the fossil should be 60mm. in length, indicating nearly either *Macropus magister*, *Halmaturus anak* or *Halmaturus dryas*, and since we find it in contiguity with mandibles of the last species, we may with some show of reason, refer it to that species. On the same grounds the distal third or thereabouts of a right femur may also be attributed to *H. dryas.* In this both condyles are sufficiently well preserved to indicate their form, which in the case of the inner condyle of the preceding fossil seems to have been considerably altered by the decay of its inner edge. This condyle is peculiar in shape, being broader than the outer one and much more revolute on its inner edge than in any living Macropod. Across the condyles the bone is 59mm. in breadth. It most probably belonged to a large individual of *H. dryas;* less probably under the circumstances to *H. anak.*

Tibias. A part 50mm. in length of the lower half of a shaft. At the distal end it measures 28mm. in breadth against 24·5 in the corresponding place in *M. giganteus.* The lower molar series would in this individual be 55mm. in length, by virtue of which the bone may be added to the other remains of *H. dryas.* It has no peculiarity worth mentioning. The same may be said of the middle third of a shaft from an animal of approximately the same size and presumably the same species.

Metatarsal. A distal two-thirds 100mm. long of a great metatarsal indicates a somewhat shorter and distinctly stouter bone than that of *Macropus giganteus.* This accords with the great metatarse appropriated to *H. dryas* in a restoration of the foot of that species exhibited with others in the Queensland Museum.

Halmaturus anak, Ow.

Femur. The presence of this species is intimated by the distal half of a right femur having in its present condition a breadth across the condyles of 65mm. This breadth in itself indicates a molar series of nearly 68mm. in length. The fossil, therefore, as we see it belonged either to a small individual of *H. anak*, Ow., or *M. pan*, mihi, to the former preferably since the Giant Wallaby has left its remains in superabundance and the Kangaroo rivalling it in size in comparative rarity. But the fossil does not yield by any means the measurement of the original bone, the decay of its external surface having much diminished its size.

Halmaturus cooperii, Ow.

Tibia. A cavity in a block of matrix has been occupied by the second, fourth or so of the shaft of a tibia of about the same size as that of *Halmaturus agilis*, a species corresponding in size to *H. cooperi* to which it is referable.

Nototheriidæ.

Radius. A subcylindrical piece of bone 150mm. long and 20 broad at the upper, 30 x 33 at the lower end where its internal cavity has passed into cancellated structure, has much the appearance of the lower half of the radius of a small species of this family, very possible it had its origin in *Euowenia grata*, mihi; to what other animal or part of the skeleton to refer it, I do not know. The osseous remains in a cavity left in another mass of the matrix appears to be second example of the same bone.

Rib. A portion of a rib 130mm. long and about 29mm. thick at its proximal end has doubtless been derived from one of the Nototheriidæ, but to which of them is as yet beyond conjecture. Bones incertæ sedis.

Pelvis. A portion of the acetabular region of the pelvis of a large Macropod too fragmentary to yield reliable measurements.

Tibia. A cavity of the matrix containing remains of bone which apparently have been derived from the upper half of the shaft of a tibia.

Rib. Another cavity in the same piece of matrix with the *H. cooperi* tibia, represents a portion of a rib, 30 x 11 at its distal surface of fracture. The number of large Macropods to any one of which it may possibly have belonged is too great to allow even a guess at its identity.

The remaining seven fragments of bones are to the present examiner without clue to their identification.

APPENDIX B.

On the Graptolites of the District.

By T. S. HALL, M.A.

Messrs. Officer and Hogg have kindly placed the graptolites found by them in my hands, and their collection is supplemented by some specimens gathered by myself at localities to which they guided me on a couple of visits in their company. The collection is small and the localities are few, but a very fair idea of the horizon of the beds can be gained in most cases.

1. *Basin Creek*, Coimaidai.

In blue, very hard, cleaved slates.

Didymograptus bifidus, J. Hall; *D. murchisoni*, Boeck; *D. extensus*, J. Hall; *Tetragraptus quadribrachiatus*, J. Hall; *T. serra*, Brong.; *Phyllograptus typus*, J. Hall; *P. angustifolius*, J. Hall.

The "Tuning-fork Graptolites," of which *D. murchisoni* is typical, seem to occur on a lower horizon in our Victorian rocks than they do in the Northern Hemisphere. In Castlemaine, where the position of the beds containing them is sufficiently clear, they are sparingly associated below with the topmost beds containing *Tetragraptus fruticosus*, rapidly attain their maximum of development and then suddenly disappear. The different forms of *Phyllograptus* range far higher than they do and are abundant long after the *murchisoni* group has died out. With us the "tuning-fork" forms never occur but in association with *Phyllograptus*, while in Europe at any rate, they appear to be specially typical of beds above those containing *Phyllograptus*. It is not a case of *Phyllograptus* ranging higher but of the occurrence of the *murchisoni* group at a lower horizon for several species of *Tetragraptus*, *Dichograptus*, etc., occur above it. Messrs. Nicholson and Marr[1] regard the *murchisoni* group as the direct descendents of *Tet. fruticosus*, so that its position cannot be considered anomalous. The horizon of the present beds appears identical with that of the "Wattle Gully beds" in Castlemaine.[2]

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[1] Geological Magazine, 1895, p. 535.

[2] Proc. Roy. Soc. Vic., N.S., vii., 1895, p. 76.

2. *Cockatoo Gully*, above Coimaidai.

Didymograptus extensus, J. Hall; *D. caduceus*, Salter; *Tetragraptus of quadribrachiatus*, J. Hall; *Phyllograptus ? angustifolius*, J. Hall.

The specimens are as a rule badly preserved. The specimens of *D. caduceus* are common and very large, as is usual in the higher zones at Castlemaine. There are also present fragments of a large species of *? Didymograptus.* Its branch has a very slight sigmoidal curvature, but though I have many fragments from several horizons at Castlemaine I am uncertain of its generic position. As all the species, even those provisionally identified, have a considerable range in the Lower Ordovician the exact horizon is uncertain.

3. *Back Creek*, Coimaidai.

The only species obtained was *D. caduceus*, of which several examples were obtained, one gigantic specimen measured 7·5 cm. in length and is far the largest I have seen. The specimens came from a loose block, but Mr. Officer thinks it had not travelled far.

4. *Deep Creek*, near Melton.

The specimens came from an outcrop just below the bridge by which the Melton to Bacchus March road crosses the creek.

Didymograptus caduceus, Salter; *Tetragraptus serra*, Brong; *Dichograptus ?* n. sp., *Phyllograptus typus ?* J. Hall; *Diplograptus* sp., *Lingulocaris maccoyi*, Eth., jr.

The slates are much decomposed but are very rich. The *Dichograptus* resembles a species occurring in the "Didymograptus caduceus zone" at Castlemaine, and appears to be new. The *Diplograptus* is very abundant but indecipherable. The zoological position of forms very like our *Lingulocaris* seems uncertain, for Gurley[1] considers it a graptolite and not a crustacean. The horizon is probably near the *D. caduceus* zone, probably somewhat higher as *Diplograptus* is so abundant.

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[1] Journal of Geology, vol. 4. pp. 85, *et. seq.*

Art. XIX.—*The Northward Extension of the Derrinal Conglomerate (Glacial).*

By E. J. Dunn, F.G.S.

[Read 9th December, 1897.]

So much interest has been aroused in all that pertains to the evidence of ancient glaciation in Australia and elsewhere, and every additional fact developed excites such keen attention that it is a pleasure to record some new localities.

On the 1st of November last a very interesting locality came under observation near the northern boundary of New South Wales, latitude about 29° S. It is at the Ashford Coal Field, Fraser's Creek Station, Severn River, Arrawatta County. The Derrinal Conglomerate forms the basal beds of the Ashford Coal Field.

At Fraser's Creek homestead granite outcrops on the west side of the river Severn, and strewn over this are numerous pebbles and boulders of many varieties of porphyry, granite, etc., derived from the glacial conglomerate which has been denuded at this site. Scratched surfaces are plentiful and the variety of pebbles, unlike any in place within the present watershed of the Severn, are characteristics of the Derrinal Conglomerate. The hard porphyry boulders have retained the scratches best of all; a specimen of these is exhibited.

About two miles south from the homestead is Coal Gully where a few hundred tons of coal have been mined, and along which the section is made. To the east are brown shales and sandstones, much buckled and disturbed, these are referred to by the N. S. Wales geologists as Carboniferous Strike, N. 10 W. Dip easterly 20°. Pitch at junction with the conglomerate N. 23°. On the upturned edges of these Carboniferous (?) rocks the Derrinal Conglomerate was laid down and then succeeded in a conformable manner to the conglomerate, black shales, grey shale, a coal seam, then thick bedded sandstone, etc. At this site the conglomerate is represented by small, subangular fragments of claystone in a light grey clayey matrix, with bands of ferruginous character near the floor, total thickness of the conglomerate 22 feet. Above the conglomerate is 13 feet of black shale, then 9 feet of black shale and impure coal (bass), then 4 feet of black shale and 1 foot of grey shale full of Gangamopteris and other plant-remains, then 7½ feet of black shale and dirty coal. Above this is a massive coal seam 27 feet thick, covered by light grey false-bedded sandstone with plant impressions. Further westward Post Pliocene deposits obscure the older rocks for about one chain, then yellowish-grey sandstones again crop out. Two hundred yards further west granite occurs, and this forms a range running N. and S. for some miles. The Derrinal Conglomerate and conformable overlying shales, coal, etc., all dip westward at about 56°, and as they were probably laid down in a more nearly horizontal manner a fault is indicated apparently near their junctions with the granite. The granite is older than the conglomerate, as proved at Cherry Gully Railway Station, Queensland.

This remarkable coal seam was reported upon by Professor David in 1883 and by Mr. Pittman, Govt. Geologist, in 1896,[1] but the interesting nature of the conglomerate associated with it appears to have escaped notice.

The practical importance of this section in which the Derrinal Conglomerate is associated with a thick and valuable seam of coal is not confined to Australia alone, for in South Africa the corresponding glacial conglomerate (which I named "Dwyka Conglomerate," after a site where it is characteristically represented) is associated with black and coloured shales as at Ashford Coal Field. Glossopteris, Gangamopteris, etc., occur in the shales just above the the glacial conglomerate both in South Africa and in Australia, and sub-Karroo coal seams will no doubt be found that will correspond with the Ashford seam.

In the Quarterly Journal of the Geological Society (London), Vol. LIII, Part 3, No. 211, p. 310 *et seq.*, August, 1897, a paper is published by Mr. David Draper on the occurrence of Glossopteris, Gangamopteris, etc., associated with coal seams at

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[1] Records Geological Survey of N. S. Wales, vol. v., part i., page 26.

Boschman's Fontein, Maggie's Fontein, etc. Transvaal sections are given at pp. 312 and 313. "Boulder beds" are mentioned and shewn, and these are probably Dwyka Conglomerate and the overlying beds containing the coal seams and Glossopteris, etc., are doubtless conformable with the "boulder beds." The resemblance of these Transvaal occurrences to the Ashford coal and its associated glacial conglomerate and fossiliferous shales is most striking. The Ashford coal measures undoubtedly represent the lowest horizon of coal bearing beds in New South Wales on the Greta coal measures.

The coal seams and fossils occurring above and below them, as described by Mr. Draper, correspond with the Ashford horizon and therefore belong to the lower coal measures of South Africa —the Kimberley shale horizon—and not to the Molteno coal measures of the Stormberg series, which are much higher in the geological scale. The Molteno coal measures are characterised by Taeniopteris, Odontopteris, Zamites, etc., in great abundance; a very characteristic feature of these fossil ferns is that the stems bifurcate. The Molteno coal measures correspond with the upper coal measures of New South Wales, the Warwick coal measures of Queensland, and the coal measures of N. E. Tasmania.

If the Boschman's Fontein and other coal deposits described by Mr. Draper as associated with Glossopteris, Gangamopteris, etc., belong to the Kimberley shales horizon then the sub-Karroo coal seams are proved absolutely to exist.

In the shales associated with the faulted coal at Rabie's Farm, Camdeboo, Glossopteris, Equisetae and perhaps Gangamopteris, were found. These fossils are found in the Kimberley shales at several points, but never associated with the Molteno coal measures.

To revert to the Ashford locality, there is, about ½ mile south of Coal Gully, another small gully running east into the Severn River, called Sheepskin Gully. About ¼ mile from the river up the gully, the Derrinal Conglomerate occurs resting unconformably upon the upturned edges of the carboniferous (?) beds, these latter dip E. 66°, while the glacial conglomerate dips W. 26°. At this point the conglomerate consists of small pebbles having characteristic glaciated forms, some showing striations; they are principally of claystone[1], but there are odd examples of well rounded lydianite, porphyry, granite, etc., also the conglomerate beds are rudely stratified and are interbedded with well stratified shales and sandstones. In some of these beds Glossopteris and other plant-remains are abundant. At one point on the N. side of the gully, a little coal was observed, but whether this was a loose block or not is uncertain. The gully bifurcates a few chains further up from where the conglomerate shews nearest the river, and after a few chains more of conglomerate, shales and sandstones are traversed in a westerly direction, the Carboniferous (?) beds again occupy the surface. The width of conglomerate and alternating beds here would be about 12 chains from E. to W. The beds all dip at low angle to the W., but whether this is due to a kind of false bedding or whether to subsequent faulting remains to be worked out. West at a short distance is granite, south one mile is an outcrop of Gympie Beds, shales, and sandstones, highly inclined and traversed by a mineralized quartz vein. Newer than these are the Carboniferous (?), sandstones and shales which are free of quartz veins. On the upturned edges of these Carboniferous (?) beds is the glacial conglomerate and associated shales, sandstones and coal seams. Again on the upturned edges of the Derrinal Conglomerate and associated beds which dip at angles ranging from 26° to 56° to the W., is a Post Pliocene deposit a few feet thick, consisting of soft loose grit, and this in turn is covered by Recent surface soil from 1 to 3 feet thick.

An immense area of Derrinal Conglomerate must have been denuded to supply the great pebble beaches along the Severn River with material so unlike any rocks now existing within its present watershed.

In Queensland the Derrinal Conglomerate is well shewn resting on granite at Cherry Gully Railway Station, 187 miles south of Brisbane; it is observable in the cuttings along the line for over a mile in length. The pebbles where weathered out, are of the usual glacial character and of many varieties of rocks, some show distinct scratches. The matrix is granitic detritus.

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[1] Literally not felspathic porphyry.

At Silver Wood Railway Station, 179 miles from Brisbane, nearly horizontal glacial conglomerate rests on the upturned edges of the much contorted Carboniferous (?) beds. Here the pebbles are of a great variety of rocks glaciated in form and in some cases polished and scratched. As at the Ashford locality the conglomerate rests on Carboniferous (?) beds, but the overlying shales, etc., were not observed. The conglomerate continues for some miles further northward along the railway towards Warwick. Similar deposits of the Derrinal Conglomerate should be found still further north, both E. and W. of the Dividing Range. If the occurrence of the same conglomerate in South Africa (the Dwyka Conglomerate) is any guide then the Derrinal Conglomerate may be looked for at intervals right round Australia at the base of the Permo-Carboniferous, and later rocks that occupy so great an area of the interior of the continent.

Apart from the scientific interest which centres in the Derrinal Conglomerate as a geological bench-mark connecting Australasia with South Africa and possibly with Asia, and from the speculation it excites as to what conditions could have prevailed to produce a conglomerate so protean in its aspects, there is the very practical fact that the Derrinal Conglomerate forms the floor of all our valuable coal seams, and, what is almost as important in this droughty land, also the floor of the strata from which artesian water is obtainable.

ART. XX.—*Note on Perforated Rocks from West Australia.*

BY E. J. DUNN, F.G.S.

[Read 21st October, 1897.]

In 1893, when at Bayley's Reward Mine, near Coolgardie, the manner in which a decomposed steatitic rock at the surface was perforated attracted my attention and a specimen was secured. This rock is burrowed and tunnelled through and through in a manner greatly resembling earth tunnelled by worms. Cross sections of these tunnels are circular and about $\frac{1}{4}$ inch in diameter. These perforations were only observed at the surface in an open quarry.

Early in this year, when visiting the Vale of Coolgardie Mine, seven miles north of Coolgardie, the decomposed granitic rock which here encloses the quartz reefs was found to be much perforated at the surface. Still more remarkable, at the 80 feet level on the underlay of the lode, a face was exposed along the course of a joint parallel to and a few inches from the reef and on the hanging wall; this face was a network of burrows. Red surface soil was present in all these burrows. At the surface the general mass of the soft granite appears to have been perforated, but at the 80 feet level the tunnels appear to have been confined to one particular joint on the hanging wall of the reef. Possibly this joint permitted the moisture after rains to sink down deeply and these persevering little miners followed in search of water; or else this joint may have been chosen as the easiest ground to mine in.

From the abundance of the burrows at the 80 feet level, it is highly probable that they may extend quite down to the 100 feet level; this will be disclosed as mining proceeds.

Roots of trees (Eucalypts are growing on the surface) follow these burrows to the 80 feet level. In some of the mines tree roots have been observed to a depth of 150 feet vertically from the surface in West Australia.

The diameter of the perforations at the Vale of Coolgardie Mine ranges from $\frac{1}{8}$ to $\frac{1}{2}$ inch. The tunnels are very tortuous and branching.

At the Hill End Mine near Broad Arrow, at a depth of 70 feet vertically from the surface, the country rock in which the auriferous quartz reef runs resembles that at Bayley's Reward Mine in the quarry. It is also well tunnelled; there is no joint here in the rocks as at the Vale of Coolgardie Mine.

Whether these very remarkable perforations are the work of worms, larvae or flies is quite uncertain, but by calling attention to these curious "deep sinkings," miners may become interested and so secure examples of the pioneer miners that have executed so much work before the gold miner reached Western Australia.

It is not known if these burrows are still being extended or not, nothing to indicate very recent work was observed.

Art. XXI.—*The Structure of an Australian Land Leech.*

By Ada M. Lambert, M.Sc., Melbourne University.

Communicated by Professor Baldwin Spencer.

(With Plates X., XI., XII., XIII., XIV.)

[Read 9th December, 1897].

At the suggestion of Professor Baldwin Spencer, and under his supervision, I have undertaken the following work on the structure of an Australian Land Leech.[1]

To him my best thanks are due for his kindness in allowing me the use of the Biological Laboratory, where my researches have been carried on, for specimens placed at my disposal, and especially for much helpful advice and criticism.

I wish also to acknowledge my gratitude to Mr. C. French, Government Entomologist of Victoria, for his untiring efforts to secure specimens. The temporary disappearance of late of the land leech usually so abundant in the gullies round Melbourne, is, owing probably to a succession of exceptionally dry seasons during the past few years.

Further, I take this opportunity of thanking Dr. J. Chalmers Baird, Mr. M. P. Fox, and Dr. O. V. Lawrence, for Victorian specimens; also Mr. Eff. D. Lawrence, to whom I am indebted for Tasmanian specimens.

Land leeches are found in various parts of Victoria, chiefly in the gullies of the ranges, specimens having been obtained from Fern Tree Gully, Beaconsfield, Healesville, Omeo and Gippsland, in Victoria; the Western Tiers in Tasmania; and the Blue Mountains in New South Wales. They are found crawling over ferns, mosses, and damp logs, with their characteristic loop-like movement. It has not yet been ascertained that the New South Wales is identical with the Victorian, which is, however, certainly the same species as the one named by Professor Blanchard from Tasmania.

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[1] The species here dealt with is *Philæmon pungens*, which was named by Professor Blanchard from specimens sent to him by Professor Spencer. The description of the species has not yet been published.

So far as is known at present the land leech is not found in South Australia, a fact to be accounted for, doubtless, by the dryness of the atmosphere, and lack of moisture in the gullies.

This little animal varies much in size. When contracted in spirit some specimens are but 7 or 8 mm. in length, others—the Tasmanian—measure from 25 to 30 mm.

Whitman[1] in his paper on the leeches of Japan says: "The Australian species, for which I am indebted to Mr Haswell, differs from all other species, that I have thus far examined, in having only two jaws. The latero-ventral jaws are present, but the median dorsal jaw is entirely absent. This remarkable distinction, taken together with the fact that the genital orifices are separated by seven and a half rings instead of five as in the case of most other land leeches, seems to make necessary the establishment of a new genus, for which I propose the name Geobdella."

This evidently differs from the leech under investigation, for though the lattter possesses but two jaws, there is no doubt whatever that the genital openings are separated by four rings only, which is an indication that a typical segment consists of four annuli. Until Professor Blanchard's recent work it was generally stated that in the Gnathobdellidæ each unabbreviated somite possessed five annuli. Many species belonging to this family, however, have been shown to form exceptions. Professor A. Oka in his paper on "Some new Japanese Land Leeches" (1895) has described three new species belonging to an entirely new genus, to which he gives the name Orobdella. The number of rings in an unabbreviated somite, characteristic of this genus, varies, but is constant for each species. Thus *O. whitmani* has in all eighty-eight rings, each complete somite consisting of four rings. *O. ijimai* one hundred and twenty-nine with six forming a segment, and *O. octonaria* one hundred and seventy-one, with somites of eight rings each.

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[1] Q.J.M.S., No. 26, 1886, p. 317.

Professor Blanchard, as quoted by Oka,[1] divides the Hirudinea into:—

1. Rhynchobdellidæ.
2. Arhynchobdellidæ.
    - Fam.—Gnathobdellidæ.
        - Aquatic.—Hirudo, etc.
        - Terrestrial.—Hæmadipsa, Xerobdella, Mesobdella.
    - Fam.—Herpobdellidæ.
        - Aquatic.—Herpobdella, Trocheta.
        - Terrestrial.—Cyclicobdella, Lumbricobdella, Orobdella.

According to the characteristics of the genera of the Gnathobdellidæ, whose members are exclusively terrestrial, the Australian land leech resembles Hæmadipsa more than any of the others. It possesses five pairs of eyes, a point in common with Mesobdella but differing from Xerobdella. Philæmon, however, is unlike these three genera, in that it has but two denticulated jaws.

In counting the annuli or rings, and fixing the boundaries of the somites of the leech, different workers have adopted different methods. Some begin with the first oculiferous ring on the dorsal surface, others with the first complete ring on the ventral. Oka, in the paper on the Japanese Land Leeches, already referred to, mentions these different methods and adopts Apathy's plan of counting every ring in the body, whether in front of or behind the first pair of eyes, as being the least artificial. He also calls attention to the fact that "each apparent ring at the anterior extremity of the body has not of necessity the value of one morphological ring." In the present paper I have counted every ring, incomplete as well as complete. The first complete annulus is situated immediately behind the fourth pair of eyes (Figs. 1, 2 and A), and this, together with the one following it, forms the lower lip of the anterior sucker (Figs. 1 and A). The complete annuli extend on the ventral surface to the acetabulum (76th annulus), making in all seventy-two complete rings. At the anterior end, in front of the first complete ring, there is at the dorsal surface an annulus bearing the fourth pair of eyes. The first three pairs situated in front of these no doubt represent rings but are not easily distinguishable.

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[1] On Some New Japanese Land Leeches. Journal of the College of Science, Imp. Univ., Japan, Vol. viii., 1895, p. 302.

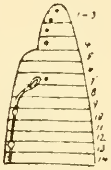

FIGURE A.

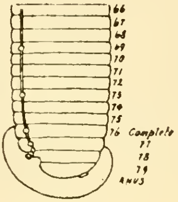

FIGURE B.

At the posterior end behind the last complete annulus there are three incomplete rings which end at and help to form the papilla-like structures beneath which opens the last pair of nephridiopores (Figs. 2 and 4).

Thus there are in all seventy-nine annuli; at the anterior end three, or their representatives, followed by one incomplete ring, then seventy-two complete annuli, and behind these, three seen only on the dorsal surface.

Considering the first three pairs of eyes to be on rings of their own, the fourth pair is borne on the 4th ring, and the fifth pair on the 7th, that is the third complete ring.

Whitman[1] in the paper previously quoted from on the Leeches of Japan calls attention to this arrangement, and says that this absence of a ring between the third and fourth pair of eyes is characteristic of all land leeches. Counting back from the anterior end, there are on the mid-ventral surface two small openings, one, the male reproductive aperture on the posterior edge of the 26th annulus, the other, the female on the posterior border of the 30th.

It has been shown by De Quatrefages, Gratiolet, Vaillant, and Bourne, as quoted by the latter,[2] that the annulations of the leech do not represent true somites. These are made up of three or more annuli according to the genus and species.

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[1] *Loc. cit.*, p. 324.

[2] Contributions to the Anatomy of the Hirudinea, Q.J.M.S., vol. xxiv., 1884, p. 42.

Whitman determines the segments by the position of the segmental papillæ, which he states are present on the first ring of every somite. Oka is unable to fix the somites by this means and points out that if these papillæ were as distinct in all species as those described by Whitman it would not be difficult to make out the somites and the number of annuli contained in each. I have found the same difficulty in determining the somites by the papillæ. In many of the specimens it is quite impossible to detect any such sensory organs except by means of sections; other leeches, however, which resemble the former in every respect, possess on every fourth ring twelve papillæ. These are definitely arranged as shown in Fig. 3, and occur in constant relation to the external markings of the leech. Along the mid-dorsal surface from the anterior to the posterior end of the body is a narrow light brown band, on each side of which is a broad and darker area extending to the lateral-ventral margin. Immediately on either side of the mid-dorsal band, except at the extremities, is a series of pale grass green patches of pigment. Each patch extends through three annuli, and at its anterior and posterior end is a papilla, that is, every fourth annulus, and only every fourth, possesses segmental papillæ. The green patch is outlined in very dark brown, almost black, colouring matter. On the lateral edge, where the dark dorsal area meets the pale ventral surface, another papilla occurs, and midway between this and the dorsal papilla is a third, so that on the dorsal surface there are six segmental papillæ—that is, three on each side of the middle line.

The under surface of the leech is of a uniform light brown colour, and on the ventral surface of each papilla-bearing annulus there are, as on the dorsal, six papillæ.

As is seen in Fig. 1 there are four annuli between the male and female genital openings. By means of sections I find that the nephridiopores occur on every fourth ring, and there are also four annuli between each of the sixteen nerve ganglia in the region of the body. Therefore, it may be concluded that there are four annuli to each unabbreviated somite.

Pontobdella among the Rhynchobdellæ and *Orobdella whitmani* of the Arhynchobdellæ are the only other leeches as yet described which agree with Philæmon in this respect.

Having ascertained the topographical relation of the external rings to the nervous ganglia, these being taken on account of their more regular metameric arrangement, we may, by comparison with other leeches call the annulus in which the ganglion lies the first annulus of the somite. The nephridiopores—two—open on the posterior edge of the annulus in front of the one bearing the ganglion that is on the fourth or last annulus of each segment.

The number of somites is, of course, dependent on the number of ganglia. By dissection it can easily be seen that as in all Hirudinea, exclusive of the œsophageal and acetabular nerve masses, there are twenty one ventral ganglia, that is twenty-three ventral ganglionic masses in addition to the supraœsophageal mass. Of these the first or subœsophageal mass lies in part of the 8th and 9th annuli. By means of sections it can be seen to consist of five fused ganglia. This is the case in most other leeches. Comparing this with the structure of the unabbreviated segments where we find one ganglion to every four annuli, that is to every segment, we can only suppose that the first nine annuli containing the subœsophageal mass represent at least five somites.

These, if unabbreviated, ought to consist of twenty annuli. Reduction of the rings, or, what Whitman calls "centripetal abbreviation," has taken place, and the anterior somites have merely kept those rings which are of the highest functional value. By this means the first three segments may be regarded as consisting of three almost indistinguishable rings bearing each a pair of eyes. The next segment, IV., consists of the 4th, 5th, and 6th rings, the first of these bearing the fourth pair of eyes.

The eyes are undoubtedly modified and highly specialised segmental papillæ and ought therefore to be on the first annulus of each segment.

Segment V. begins with the 7th annulus bearing the fifth pair of eyes and has, as in segment IV., two other annuli, the 8th and 9th.

In the next ring the 10th is the second ganglion, so that the œsophageal mass may easily be regarded as consisting of the representative ganglia of the segments I.–V. Between the second and third ganglia there are two rings, so that somite

VI., like IV. and V., may be regarded as consisting of three annuli, the 10th, 11th and 12th.

The third ganglion lies in the 13th annulus, that is the first of somite VII. This is the first unabbreviated segment. Behind this are fifteen, each consisting of four annuli, the eighteenth ganglion belonging to segment XXII., being situated in the 73rd annulus. Altogether there are sixteen unabbreviated somites, beginning with the 13th annulus and extending back to the 76th, the last complete annulus. Reduction of the somites again occurs and we find the nineteenth, twentieth, twenty-first, twenty-second, and twenty-third ganglia are lodged in the acetabulum ventrally and in front of the anus, the anterior ones probably corresponding to the 77th, 78th and 79th annuli. The first four of these are single ganglia and therefore represent somites XXIII., XXIV., XXV., and XXVI. The twenty-third or acetabular mass is, however, a fusion of seven ganglia as can be easily seen either from sections or by examining the ganglion with a lens. This means, therefore, that seven somites are here represented, making in all XXXIII., which is the typical number of somites for all leeches.

The supraœsophageal ganglion lies in the 7th annulus and is connected with the subœsophageal mass by nerve fibres passing round the pharynx. This ganglion, developing as it does, quite independently of the ventral nerve chain, does not represent a segment but the prostomial lobe of the embryo.

The relationships of the ventral ganglia, somites and annuli are shown in the following table :—

GANGLION.	SOMITE.	ANNULI.
1. Œsophageal	V. (I.–V.)	7, 8, 9, (1–9)
2.	VI.	10–12
3.	VII. (unabbreviated)	13–16
4.	VIII. ,,	17–20
5.	IX. ,,	21–24
6.	X. ,,	25–28
7.	XI. ,,	29–32
8.	XII. ,,	33–36
9.	XIII. ,,	37–40
10.	XIV. ,,	41–44

Ganglion.	Somite.	Annuli.
11.	XV. (unabbreviated)	45–48
12.	XVI. „	49–52
13.	XVII. „	53–56
14.	XVIII. „	57–60
15.	XIX. „	61–64
16.	XX. „	65–68
17.	XXI. „	69–72
18.	XXII. „	73–76
19.	XXIII.	77 78 79 and acetabulum
20.	XXIV.	
21.	XXV.	
22.	XXVI.	
23. Acetabular	XXVII.–XXXIII.	

Oka[1] states that "Apathy and Lang divide the body of a leech into the following regions: cephalic, clitellar, median, anal, and acetabular." In Philæmon it is almost impossible to fix such divisions, as there is no strict line of demarcation between these parts, the one passing by insensible gradations into the other.

The head region may be considered to extend back to the posterior margin of the mouth and consists of the first nine annuli, that is somites I.–V. It carries the five pairs of eyes—the position of which has already been described—and the anterior sucker. This occupies nearly the whole of the ventral surface, the upper lip being formed of the part lying immediately in front of the first pair of eyes, and the lower lip of the 5th and 6th annuli, which are less distinctly separated on the ventral than on the dorsal side. In the anterior sucker lies the mouth, and attached to it are the two jaws. These are placed latero-ventrally and in some contracted specimens can be seen protuding from the anterior sucker. They are situated in somite V. Following on the head region are three somites which may be regarded as forming the neck, the first somite, VI., being the last abbreviated segment at the anterior end.

So far I cannot distinguish a clitellar region. Microscopically, as well as externally, there appears to be not the least difference between the integument in the neighbourhood of the genital organs and that of the rest of the body.

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[1] *Loc. cit.*, p. 288.

As already stated, the male and female reproductive organs open on the 26th and 30th annuli respectively, that is the second annulus of somites X. and XI., so that they occupy a similar position in their respective segments—namely mid-ventral on the posterior border of the second annulus. The median region includes the greater part of the body made up of unabbreviated somites though externally there is nothing which can determine the position or number of annuli in a segment, that is, no clearly distinguishable segmental papillæ and no visible nephridiopores. Each segment in this region possesses a ganglion, from which are given off nerves to the different parts of the segment as well as the portion of the ventral chain connecting the ganglia, a pair of nephridia, each with its excretory vesicle and external aperture, a pair of testes and a portion of the alimentary canal with a diverticulum given off on each side.

The hindermost end, including the anal and acetabular regions, again shows centripetal abbreviation (Figs. 1, 2, 3).

Behind the last annulus, 79th in the mid-dorsal line, is situated the anus on a small muscular papilla attached to the acetabulum.

Integument and Sense Organs.

The integument of this form resembles very closely that of other described land leeches. It consists on the outside of a thin transparent cuticle, beneath which lies the epidermis made up of columnar cells and simple unicellular glands, in many of which the nucleus can be clearly distinguished lying at the side, as shown by Bourne. Distributed among these cells are numerous capillaries supplied from the dorsal and ventral sinuses, and joining together to form vessels pouring ærated blood into the lateral vessels. Here also the pigment is disposed. In certain parts the epidermic cells are modified and specialised to form sense organs. Of these there are the segmental sense organs, the eyes, and the marginal lip organs—or "goblet-shaped" organs of Leydig.

In the main the sense organs of Philæmon resemble those of the leeches worked at by Whitman.

The Segmental Sense Organs. (Fig. 5).

The segmental sense organs occur on the body and head on every fourth annulus. As before stated, there are twelve situated at equal distances from each other round the first annulus of each segment. These organs are covered externally by the thin cuticle continuous over the whole body. Each consists of a group of epidermic cells longer than those of the rest of the surface, and leaning towards one another. At the base of these are four or more large clear cells, such as have been described by Whitman—each with a distinct nucleus lying in the protoplasm and also a crescent shaped vacuole (C.C.1). At the point where the protoplasm projects into the vacuole it appears denser and stains more deeply. It is possible that this may be the terminal ending of a nerve, though I have been unable to trace any definite connection with the clear cell. With this may be compared Whitman's description of the clear cells, in which he observes "a small oval area though the outline of this is not very sharp," and this area he suggests may be the nerve ending, although he cannot prove it. In the very centre are the elongated sense cells which form the important part of the organ. At the anterior end of the body some of these cells have become so drawn out as to resemble the axial fibres of the eye. I have not been able to trace any decided communication, however, between these central cells and the nerve supplying the organ, though undoubtedly there must be a connection—which in the case of Hirudo and Hæmadipsa, Whitman states he could distinctly see.

The organs are richly supplied with blood vessels, a branch usually running out at right angles to the surface of the animal and dividing so as to send branches all round the organ.

At the inner side of the clear cells are the circular muscles of the body wall. The nerve supply is derived from the ganglion of the segment to which each organ belongs.

The Eyes. (Figs. 6 and 7).

As already stated there are five pairs of eyes situated on the 1st, 2nd, 3rd, 4th and 7th annuli. With regard to structure there is little that is new to be said. As in the descriptions by Professor Whitman[1], Dr. B. L. Maier[2] and Miss Merrill[3] of the eyes of the Hirudo, Hæmadipsa, Clepsine, Macrobdella and others, so in Philæmon the eye appears to be but a more specialised and highly developed segmental sense organ. The most characteristic and conspicuous cells are the large clear cells, each with its nucleus and vacuole. These are placed round the axial fibres, as shown in Fig. 6, in a single layer. Surrounding these is a cup of pigment which is shallower and less dense on the outer posterior portion of the eye. Passing in at one side near the base of this cup is a blood-vessel (bv) which can be traced round to the other side of the cup, so that the eye is well supplied with blood. The tactile cells are somewhat elongated with nuclei visible at their inner ends.

By comparison with Miss Merrill's figures the tactile cells of Philæmon are shorter and more like the ordinary epidermic cells. With little difficulty the axial fibres in the centre can be seen. These, however, in a transverse section of the eye are very distinct. The optic nerves supplying the eyes pass off from the supraœsophageal ganglion. In some cases the nerve appears to enter the eye almost at the base, while in others it distinctly passes in at the sides of the cup. Before entering the eye the nerve divides, one branch being distributed to the cells and fibres in the cup and the other to those at the front end of the eye (Fig. 7). In one section, cells could be seen on the optic nerve, evidently corresponding to those called by Whitman "nerve ganglion cells."

The Marginal Lip Organs. (Fig. 8 and 8a).

These are the goblet-shaped organs of Leydig. They occur only in the upper lip where they are in considerable numbers set all along the margin. Each consists of one or more—generally more—groups of cells.

On the surface, as in the case of the other sense organs, they protrude slightly and are covered by a thin cuticle. The epidermic cells are much elongated to form tactile cells (T), with their nuclei placed at their inner ends. A nerve, arising in some cases directly from the supraœsophageal ganglion, in others as a branch of the optic nerve, passes up, giving off branches which supply two or more organs lying next to one another, so that the different sense organs are not necessarily supplied with differently functional nerves. The fibres enter the inner end of the groups of tactile cells and are distributed to them. I have noticed, in some sections, one or two large clear cells (c.c.) placed on the nerve fibres, the function of which I am unable to explain. As in the case of the other sense organs these on the margin of the lip are well supplied with blood by means of small vessels passing up between the ordinary epidermic cells and giving off branches which pass round the organ and supply it on all sides (Bv).

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[1] *Loc. cit.*

[2] Beiträge zur Kenntniss der Hirundineen-Auges. Zool. Jahrbuch. Bd. v., p. 552.

[3] Preliminary Note on the Eye of the Leech. Zool. Anzeig., xvii., 1894.

In respect to time of origin Whitman says that the segmental sense organs have been developed first, for the others—the non-segmental—are limited to a specialised part of the animal and have undoubtedly arisen in response to the increased needs of this part.

The functions of these various sense organs have been fully discussed by Whitman.[1] Undoubtedly the marginal lip organs subserve the sense of touch and may possibly serve as organs of smell.

The exact way in which the eyes function as organs of sight is yet to be decided. At least they can appreciate light and darkness. Owing to the fact that the segmental sense organs and the eyes both possess large clear cells—these being most numerous in the latter—Whitman concludes that both classes of organs have a common function, namely, the appreciation of light and darkness. It is also probable that the segmental sense organs act as organs of the sense of smell.

Alimentary Canal. (Figs. C., 4 and 9-19).

The alimentary canal of Philæmon resembles that of *Hirudo medicinalis* in many respects. It opens on the ventral surface at the anterior end by the anterior sucker and extends back along the dorsal surface to the posterior extremity where it opens at the anus (Fig. 4).

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[1] Q.J.M.S., vol. xxvi., p. 408.

The anterior sucker, as already described, occupies the whole of the ventral surface of segments I.–IV. Its upper lip is formed from the prostomium and is set with marginal lip organs (Fig. 8). The ventral lip consists of the 5th and 6th annuli. The sucker is muscular, and by its means the leech attaches itself to its prey for purposes of feeding. The comparatively large cavity behind this may be regarded as the buccal chamber (B.C.) or mouth—the opening from it into the pharynx being the oral aperture. The pharynx wall is muscular and made up of three folds, one median dorsal (D.F.) and two latero-ventral (L.F.). Growing up as continuations of the latero-ventral folds are two muscular jaws which project into the buccal chamber—a jaw corresponding to the median dorsal fold not occuring. The position of the jaws is seen in Fig. 9.

They have the appearance of somewhat rounded disc-like structures, the free edge consists of a thickened cuticle (cut. Fig. 10) forming a definite ridge. Along this ridge can be seen a distinct groove, in which are placed some seventy or more small denticles (D.). The denticles are not placed contiguously, and the groove between any two teeth appears to be to a certain extent closed in or filled up with tissue. This gives the appearance of the tooth being set in a little socket (Fig. 11). The denticles are conical, and curved slightly towards the mid-ventral line, the rest of the surface of the jaws is smooth and covered with the cuticle. It can easily be seen from sections (Fig. 11) that the jaws are exceedingly muscular organs with numerous glandular structures between the denticles (Fig. 12 gl.). There is little doubt that these glands resemble those of *Hirudo medicinalis* described by Croockewit.[1] The glands are unicellular, with long, narrow, waving ducts, which open on the free edge of the jaw between the denticles. The nuclei of these gland cells can be seen in many of the preparations.

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[1] Zool. Anzeig., vol. xvi., 1893.

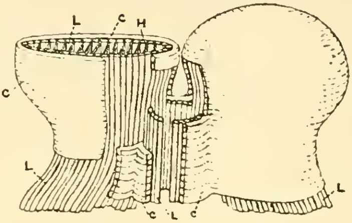

Figure C.

Of the muscles of the jaws there are three sets (Fig. C.)

A. Transverse or circular (Figs. 11, 13, C.).

These lie beneath the cuticle, and, except for this thin membrane, form the outermost layer of the jaws. These muscles are absent only where the cuticle is thickened to form the ridge along which the teeth and glands occur. They are really a continuation of the circular muscles of the pharynx on to the jaws.

B. Longitudinal (L.)

Beneath the transverse are situated the longitudinal muscles continuous with the longitudinal of the pharynx and forming a single layer on the jaws, but increasing in size and number of layers where they are attached to the pharynx. At this point some fibres pass into the body wall but the majority run on to form the large mass of muscles on each side of the pharynx gradually merging into the body wall.

C. Dorso-Ventral (H.)

These pass through the jaw from the dorsal to the ventral side, forming its main support. They are seen just beneath the free projecting ridge and cease to exist only at the base of the jaw, where it springs from the pharynx wall.

On account of the number and arrangement of the jaws, the bite from this leech is a longitudinal slit.

Besides the outer circular and inner longitudinal muscles of the pharynx, there is a series passing in a radial direction from the inside epithelial lining to the circular muscles on the outside. These are the radial muscles (R.) and they occur only in the pharynx. The function of this part of the alimentary canal is to draw by suction action the blood, necessary for food, from animals to which the leech becomes attached.

The muscular pharynx (ph.) gives place about the middle of somite VI. to the œsophagus. This is a tube with glandular walls, surrounded by circular muscles. The glands are what I take to be the salivary glands, racemose in appearance, consisting of somewhat large clear cells and opening by very short-necked narrow ducts in the cavity of the œsophagus. This extends through somite VII. where it opens into the crop (Fig. 2), which evidently corresponds to the "stomach" in forms described by Oka and Whitman. The crop is a comparatively thin walled tube giving off eleven pairs of diverticula, one pair in each of the somites VIII.-XVII., while the eleventh pair opens in somite XVIII. and runs back parallel to the intestine as far as somite XXI. The wall of the alimentary canal in this region consists of circular muscle fibres, and a columnar epithelial lining. The alimentary canal throughout its whole length is well supplied with blood vessels. Opening from the crop is a short tube leading directly into the intestine and occupying somites XIX., XX., and XXI. (Fig. 2). This is the stomach. Its walls differ from those of both crop and intestine, in that they are made up of columnar epithelial cells very closely set and almost double the height of those of the crop. On the outside are muscular fibres—circular and longitudinal, among which lie the capillaries and numerous blood vessels. In this part of the canal digestion goes on chiefly, and from the good supply of blood vessels it would appear that absorption also takes place.

The intestine passes from the stomach in the 73rd annulus to the extreme posterior end where it opens to the exterior by the anus (Fig. 4, An.), situated on the dorsal surface in the little groove where the acetabulum joins the body wall. The wall of the intestine resembles in appearance that of the crop—that is short columnar epithelium thrown somewhat into folds so as to increase the surface. It is richly supplied with blood vessels and surrounded by muscular fibres.

Connected with the alimentary canal is a paired structure which, as far as I know, has not been found in any leech hitherto described (Fig. 17, P.O.) This double "posterior organ" lies on the ventral surface just beneath the stomach in somite XIX. The two halves can be distinguished as right and left posterior organs. They lie very close together in the mid-ventral line above the nerve cord, and extend from the fifteenth to the sixteenth ganglia, measuring 2·024 mm. in length.

Their external appearance is that of elongated narrow bodies with longitudinal markings of black pigment (Fig. 17, p.g.). Examined microscopically they are found to be exceedingly glandular organs. The internal surface is thrown into numerous folds (Fig. 18, Fld.) by the growing in of the blood vessels, thus greatly increasing the glandular surface and giving rise to the external longitudinal markings. It is difficult to obtain sections in which the histological structure of this organ can be well determined. The folds are lined by a single layer of modified columnar cells which are vacuolated at the end facing into the cavity of the organ, their outer ends staining deeply. Only very rarely can nuclei be detected.

The blood supply is very rich, vessels passing along the longitudinal grooves and ramifying everywhere through the structure. Slightly towards the inner side of the middle line at the posterior end of each organ a duct opens (Fig. 17, D.P.O.), and is continued back on each side of the stomach and intestine to the eleventh diverticulum of its own side.

Here it passes into the diverticulum (Fig. 19, D.P.O., Dvt. 11) almost at the extreme posterior end and on the inner side. The duct is formed of closely set columnar cells surrounded by connective tissue. (Fig. 19, Col. epi.) With regard to the function of these organs I am unable to offer any suggestion except they are without doubt glandular.

Vascular System (Figs. 20, 21 and 22).

The blood is red and consists of plasma and corpuscles.

In Philæmon as in Hirudo there are four main longitudinal trunks, viz., the dorsal and ventral sinuses, and the two lateral blood vessels.

The dorsal sinus lies close to, and above the alimentary canal. It is a definite structure consisting of a thin epithelial lining surrounded by connective tissue, but possessing no muscle fibres in its walls. With regard to its branches the dorsal sinus may be said to be "segmental," that is the paired branches are at any rate in the middle region, regularly repeated in the different segments, each pair corresponding to and returning blood from each pair of diverticula of the alimentary canal. At the extreme anterior end the dorsal sinus still remains a single channel disappearing in its smaller branches only at about the level of the second pair of eyes.

Between each branch from the diverticula is one bringing back blood from a nephridium. This arrangement continues back as far as the eleventh diverticula. At this point there is the usual pair of vessels from the alimentary canal walls and also the pair from the thirteenth nephridia entering the dorsal sinus at the level of the stomach.

A small branch joins the sinus, returning blood from the ventral and lateral walls of the stomach. Vessels from the fourteenth, fifteenth, sixteenth, and seventeenth nephridia pour their contents into the sinus. Posterior to this is a pair of vessels which collects blood from the intestinal wall by numerous branches. These two vessels unite and form the extreme posterior portion of the sinus.

The ventral sinus is situated immediately within the body wall in the mid-ventral line. The structure of this tube is similar to that of the dorsal sinus. Within it lies the nerve cord.

In each segment, as in the case of the dorsal sinus, vessels open into the ventral sinus, bringing blood from the organs and tissues of the animal, and from the skin of the body wall where it is aerated. The lateral vessels are found just beneath the body wall one on each side of the leech. They are larger than the sinuses, and are more definite in structure (Figs. 20, 21, 22, bv.)

The wall consists of large circular muscles (Fig. 22, cm.) which have the characteristic inner granular part, and the outer cortical layer more solid and definite. Within these muscles is a layer of longitudinal fibres (Fig. 22, LM.), muscular in appearance though very small and taking the stain faintly. These vessels owing to their muscular character play an important part in the circulation of the blood.

Each gives off a series of vessels supplying the nephridia (Fig. 20). These at first retain their muscular character, but on ramifying through the organs their muscularity becomes gradually less marked (Fig. 21 Bv. 2) and finally disappears entirely. The capillaries are distributed through the botryoidal tissue and from these branches arise which enter the sinuses.

Nephridia (Figs. D., 20 and 21).

There are seventeen pairs of nephridia, one pair being situated in each of the segments VI.–XXII.

The nephridium may be divided into three parts for the purpose of description :—

1. The internal, connected with the coelom.
2. The central, making up the greater portion of the organ.
3. The part connected with the exterior.

The internal part connected with the coelom may be called, as in other cases, the testicular lobe, but its structure is different from that of Hirudo. It is intracellular but unbranched, and lies latero-ventrally near the outer margin of the testis. The extreme end of the lobe may be called the funnel (Fig. D., fun.) Owing to the coelom being much reduced there is less work thrown on this part of the organ and it is consequently somewhat modified. Like Hirudo it consists of a group of nucleated cells which may be described as a cauliflower head being thrown into folds. It is, however, much smaller in comparison than that in Hirudo. There is no definite opening from the funnel into the coelom. In this respect it resembles both Hirudo and Aulostomum according to the descriptions given by Bourne and by Graf.[1] As far as I can make out the cells are not ciliated, so that this point and the relation of the funnels to the sinuses show distinct differences as compared with Hirudo and Aulostomum. In Hirudo, Bourne says the funnels lie in a special blood sinus—the perinephrostomial sinus—surrounded by blood and, in those segments containing testes, situated on the dorsal wall of the testes.

In Aulostomum, Graf found that the funnels lie in sinuous vesicles dorsal from the testis and at the side of the intestine.

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[1] Q.J.M.S., July, 1884 ; Trans. New York Acad. Sc., xiii., 1894.

In Philæmon the funnels do not lie in any distinct sinus, but are connected with the mass of botryoidal tissue attached on the outer lateral edge to the testis sinus. In the nephridia lying in the segments VI.–XI., anterior to the testes, I have been unable to distinguish any funnels; in all probability there are none present as in Hirudo.

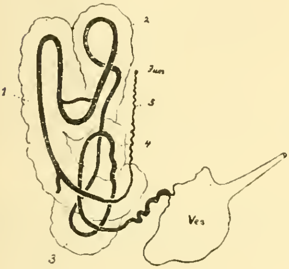

FIGURE D.

The testicular lobe (5) is continuous with the main lobe or central portion, which to some extent resembles the corresponding part in Hirudo. It consists of a primary intracellular duct together with smaller intracellular ducts opening into one another.

The cells are distinctly nucleated and their protoplasm has a radially striated appearance. The general arrangement of the lobes is seen in Fig. D.

The main duct (1) leads from the testicular lobe (3) towards the middle line and then in an anterior direction. Towards the anterior border of the segment it turns sharply on itself. This portion in the diagram is figured Neph. 1, and is continued through about two annuli when it again turns and is regarded together with the next twist as Neph. 2, which is slightly dorsal to Neph. 1. The main duct is continued towards the posterior end of the segment where it coils, forming Neph. 3, passing upwards so as to lie between Nephs. 1 and 2, where it is called Neph. 4. From here the duct is single, that is it has no branches, and is surrounded only by the cells forming it. It passes towards the side and opens into the thin walled vesicle. (Figs. 20 and D.)

The vesicle (ves. Figs. 20 and D.) lies to the outer side of the main portion of the nephridium and towards the posterior end of the segment. It is intercellular, being lined by much flattened cells distinctly uncleated, and outside these are a few muscle fibres and connective tissue.

The main duct of the central portion opens into the vesicle on its inner side, while from its outer lateral margin the excretory duct passes to the exterior where it opens on the fourth annulus of each segment, and resembles in its marginal position the land leeches of Japan described by Whitman.

With regard to the structure of the excretory duct it may be said that circular muscles occur along the whole of its length. In this respect it resembles Nephelis as described by Graf.[1] The muscles are smaller than those of the body wall, but as far as I can make out they do not increase in number or size at the nephridio-pore, which may account for the difficulty, in fact the impossibility, of detecting the openings on the external surface.

In addition to those which are present along the whole length of the duct, a special and very strongly marked group of fibres forming a distinct sphincter is present where the duct passes out from the vesicle.

So far as their relative size is concerned there is not the strongly marked difference in size between the sphincter muscles and those of the body wall such as Graf describes as obtaining in the case of Hirudo, nor, except so far as size is concerned, does there appear to be any difference in the structure of the two in Philæmon.

I regret that I am unable to refer to the paper by H. Bolsius, mentioned by Graf in his article on the Sphincter of the Terminal Vesicle of *Hirudo medicinalis*. Evidently the sphincter described by Bolsius occurring at the entrance of the duct from the terminal vesicle is similar to that found in Philæmon, in which case the sphincter is formed of a group of circular muscle fibres somewhat smaller than those of the body wall but of the same size as the circular muscles surrounding the rest of the duct.

In a dissection it can be seen that the 1st and 17th pairs of nephridia lying in segments VI. and XXII. respectively differ in appearance from the others. The anterior (1st) is a pinkish white oval mass lying one on each side of the œsophagus towards the dorsal surface, and is much more compact than those of the other segments. The excretory duct from its vesicle runs up in the circular muscles and opens (Fig. 2) on the sixth annulus between the fourth and fifth pairs of eyes—that is on the last annulus of segment IV., there being no external opening in segments V. or

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[1] Journ. of Morphology, vol. ix., 1894, p. 485.

VI. The posterior nephridium (17th) lying in segment XXII. resembles in external appearance the majority of nephridia in that it is less compact, but it is larger. The duct, however, from the excretory vesicle passes back and opens on a small papilla-like structure formed by the 78th and 79th annuli, so that is there is no external opening in segment XXII. nor in segment XXIII. (represented by 97th annulus) but the orifice occurs on the posterior edge of what represents segment XXIV. This modification in the arrangement of the 17th nephridium may be compared with that which takes place at the anterior end.

Reproductive Organs. (Figs. E. and 2).

The reproductive organs are situated in the middle region of the body on the ventral side of the alimentary canal and above the nerve cord.

The male organs consist of ten pairs of testes arranged on both sides of the nerve chain in segments XII.–XXI. inclusive. Each testis lies in the second and third annuli of its segment and is spherical in shape. The spermatzoa are developed in these in regular masses as in other cases.

Attached to the lower and outer edge of the testis is a mass of botryoidal tissue. At the outer side of the testis sometimes from its anterior, sometimes from its posterior margin, opens the vas efferens, a small definite walled duct. Each of these vasa efferentia opens into the vas deferens of its own side, which runs from the tenth pair of testes forwards as far as the twenty-sixth annulus, that is about the level of the male external opening.

The vas deferens remains up to this point of uniform size. Here it turns, passing towards the posterior end (on the ventral surface) and becomes exceedingly fine. About the region of segment XII. it dilates into a very thick walled and much coiled tube, which may be called the right or left epididymis. These structures, continuous with their vasa deferentia lie in the middle line dorsal to and about the level of the upper part of the vagina.

The epididymis of the left side lies anterior to the right in the middle line.

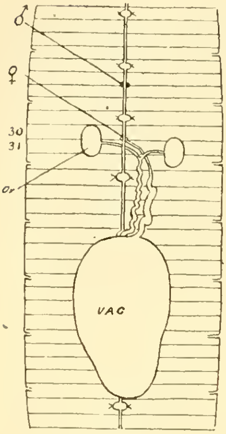


Figure E.

About the 39th annulus the epididymis of each side runs forward as a straight tube opening into a somewhat muscular sac which opens to the exterior on the lower edge of the 26th annulus, that is on the second annulus of segment X. The female organs consist of a single pair of ovaries (Fig. E. ov.) lying one on either side of the nerve cord in the 30th and 31st annuli. They are small rounded bodies about the size of the testes and well supplied with blood. From the inner edge of each ovary opens a duct—the right and left oviduct. The left oviduct passes on the ventral side of the nerve chain, and joins the right close to the middle line. The single duct thus formed is somewhat coiled with fairly thick walls. It opens in the 37th annulus into the vagina. This organ (vag.) is large and extends from the 37th to the 48th annulus; it is ovoid in shape, broader at its anterior than at its posterior end. Its walls are exceedngly thick and glandular.

There is no appearance of an albumin gland, such as is found in many other leeches, nor can I detect any particular portion of the vagina wall specially modified to act as such. From the dorsal surface at the anterior end opens the external reproductive duct. This is slightly coiled. It passes to the right of the main duct, underneath, that is on the ventral side of the right oviduct, and opens on the lower edge of the 30th annulus at the female external reproductive opening.

The reproductive organs are well supplied with blood. A branch from the lateral vessel runs along the hair-like continuation of the vas deferens to the epididymus, where it breaks up to supply the walls. The capillaries join together and enter the ventral sinus. Each pair of testes receives its supply from the lateral vessel of its own side, and returns its blood to the ventral sinus.

Branches of the lateral vessel pass to the ovaries and a somewhat large vessel runs along with the external reproductive duct giving off small branches along its course and finally breaking up in the wall of the vagina.

EXPLANATION OF PLATES.

PLATES X.—XIV.

Fig. 1. Diagrammatic plan of the annuli and segments of *Philæmon pungens.*

Fig. 2. Diagrammatic plan of the structure of *Philæmon pungens.* The dotted outline represents the alimentary canal. The female reproductive organs are omitted. Two only of the nephridia are represented. The nephridial pores are indicated on the left side, the most anterior pore lying in the sixth annulus. Neph. represents the opening of the last nephridium. The posterior organs are indicated with their ducts opening into the last pair of diverticula of the crop.

Fig. 3. Dorsal view of *Philæmon pungens.* × 3.

Fig. 4. Dorsal view of the posterior extremity of the same. × 6. An. Anus. Neph. 17, opening of posterior nephridium.

Fig. 5. Section through a segmental sense organ drawn under Zeiss, F. oc. 2. The four clear cells are shown. In the upper left hand one the nucleus can be seen. Ax. Axial fibres of the eye. n Nerve.

Fig. 6. Longitudinal section through an eye. Drawn under Zeiss, C. oc. 2. The clear cells are seen lying in the pigment cup. c.c.1. The central projection into the vacuole of the clear cell. Bv. Blood vessel within the pigment cup.

Fig. 7. Outline drawing of a longitudinal section through an eye to show the division of the nerve supplying the organ.

Fig. 8. Section through one of the marginal lip organs. Drawn under Zeiss, F. oc. 2. T. tactile cells. C. cuticle. Bv. blood vessel. Nci. nuclei of tactile cells. Tc. cut ends of tactile cells. C.C. clear cells. N. nerve.

Fig. 8*a*. Small portion of nerve supplying one of marginal lip organs showing ganglion cells on course of nerve fibres. Drawn under Zeiss, C. oc. 2. G.C. ganglion cell.

Fig. 9. View from the ventral surface, much enlarged of the two jaws.

Fig. 10. One of the jaws showing the depressed groove in the cuticle (C) along which the row of denticles is attached (D).

Fig. 11. Transverse section of jaw. Drawn under Zeiss, C. oc. 2. Cut. cuticle. D. denticle. Gl. glandular structure opening between two consecutive denticles. C. circular muscle fibres. L. longitudinal muscle fibres. C.t. connective tissue.

Fig. 12. Transverse section of jaw across a gland lying between two consecutive denticles.

Figs. 13-16. Sections across the jaw in a plane transverse to the length of the body. Drawn under Zeiss, A. oc. 2. The most anterior section is represented in Fig. 13. In Fig. 15 the right half lies anteriorly to the left half. L. longitudinal fibres. C. circular fibres. H. dorso-ventral fibres. Ph. pharynx. D. denticles. Gl. gland. Ce.G. cerebral ganglion. Bv. blood vessel. S.G. subœsophageal ganglion. R. radial muscles. D.F. dorsal fold of Pharynx wall. L.F. the two lateral folds of Pharynx wall.

Fig. 17. Much enlarged view of the Posterior Organs (P.O.). Dvt. II. most posterior diverticulum of crop close to the posterior end of which opens the duct from the Posterior Organs.

Fig. 18. Transverse section of Posterior Organ. Drawn under Zeiss, C. oc. 2. Fld. longitudinal folds on which lie the gland cells.

Fig. 19. Section across the opening of the duct of the Posterior Organ (D.P.O.) into the diverliculum of the

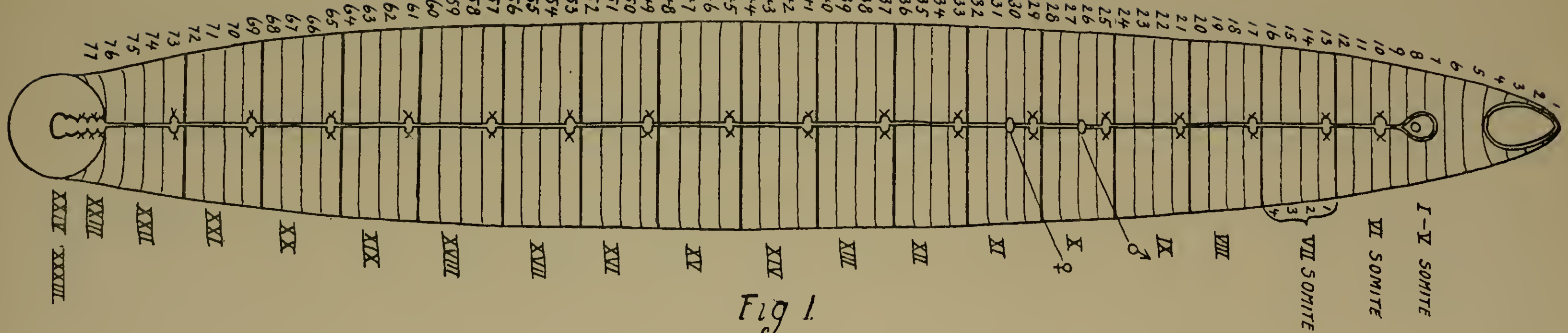
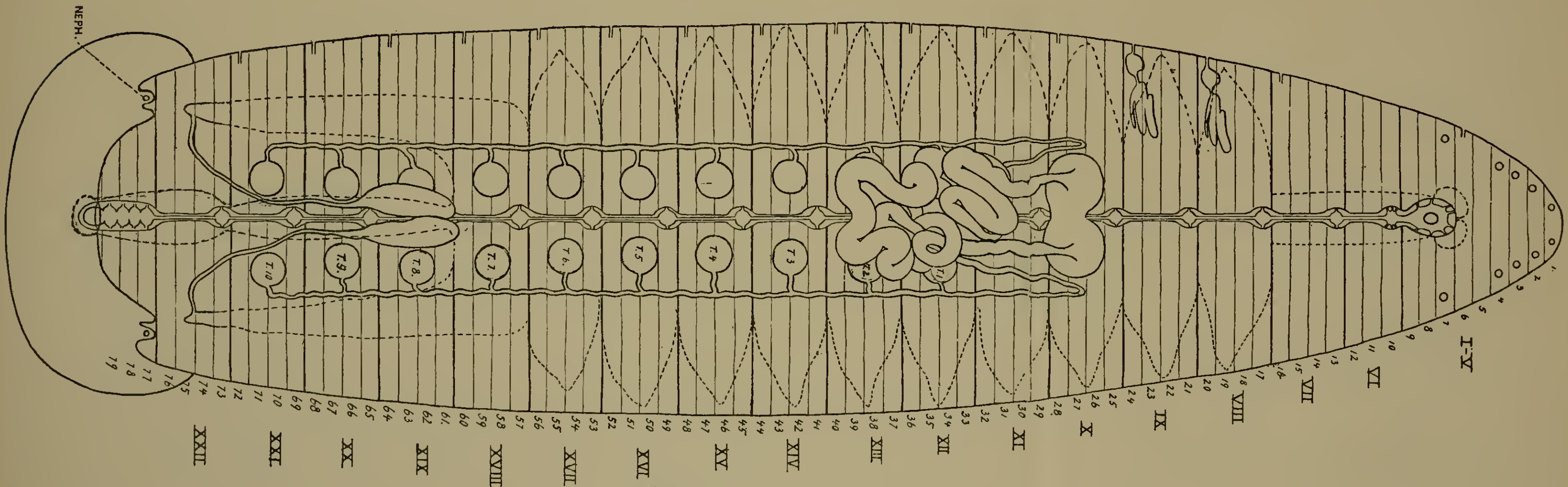

I–V SOMITE
VI SOMITE
VII SOMITE
1
2
3
4
VIII
IX
♂
X
♀
XI
XII
XIII
XIV
XV
XVI
XVII
XVIII
XIX
XX
XXI
XXII
XXIII
XXIV–XXXIII

Fig 1.


NEPH.
T.10
T.9
T.8
T.7
T.6
T.5
T.4
T.3
T.2
T.1
I–V
VI
VII
VIII
IX
X
XI
XII
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XVIII
XIX
XX
XXI
XXII

Fig. 2

Proc. R. S. Victoria 1897 Plate XI.

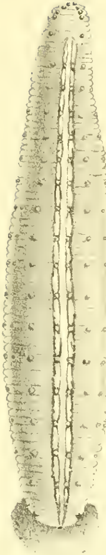

Fig 3.

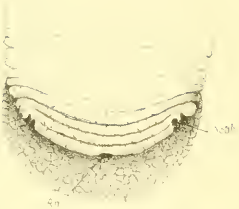

Fig 4.

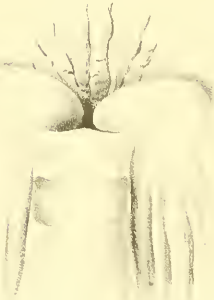

Fig. 9.

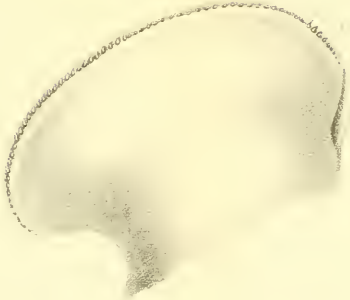

Fig. 10.

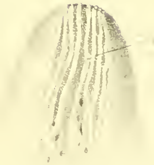

Fig. 12.

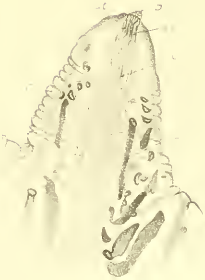

Fig. 11.

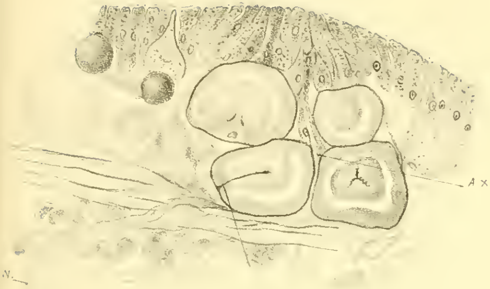

Fig. 5.

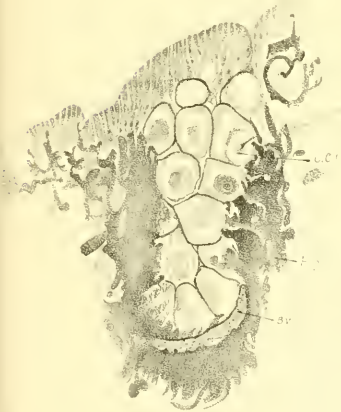

Fig. 6.

Fig. 7.

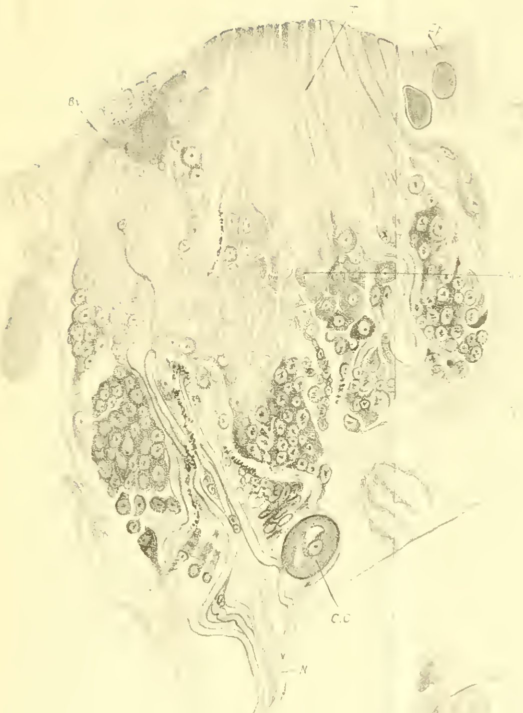

Fig. 8.

Fig. 8a.

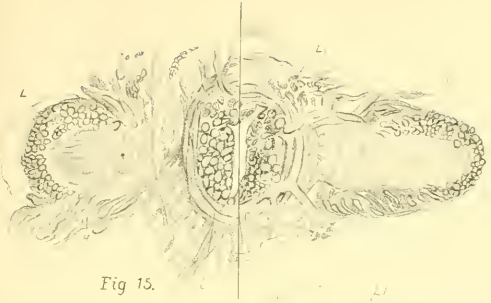

Fig 15.

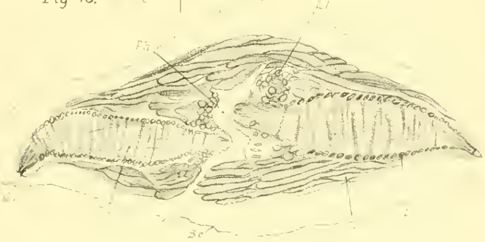

Fig. 14.

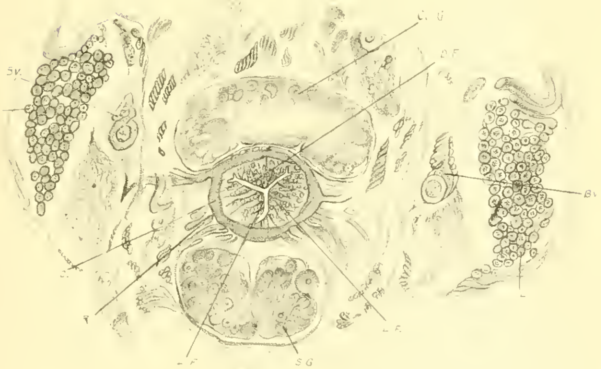

Fig. 16.

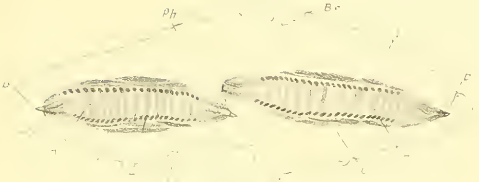

Fig. 13.

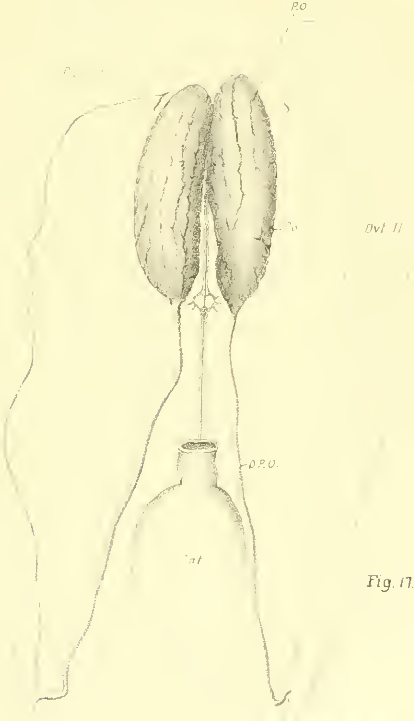

Fig. 17.

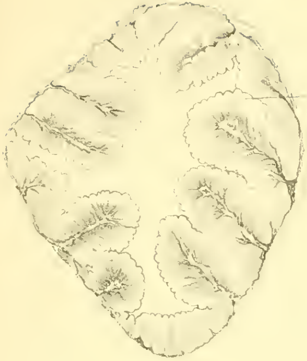

Fig. 18.

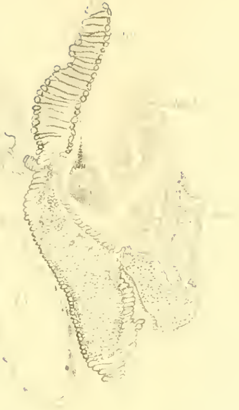

Fig. 21

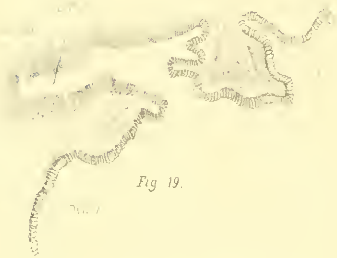

Fig 19.

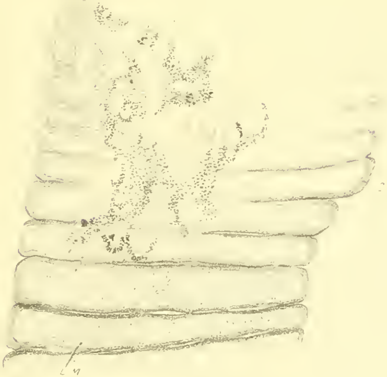

Fig. 22.

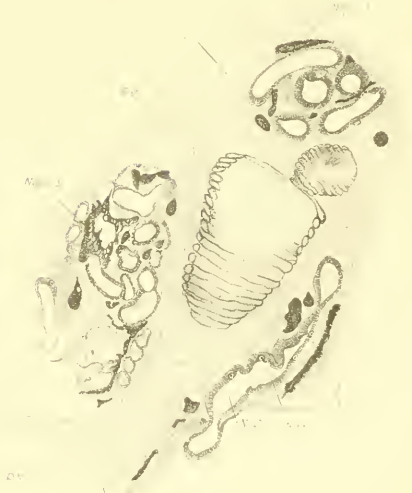

Fig. 20.

R. [illegible] M

crop (Dvt. II.). Drawn under Zeiss, C. oc. 2. Col. epi. shows the long columnar cells lining the duct.

Fig. 20. Section across portion of a nephridium. Drawn under Zeiss, F. oc. 2. Neph. 1, 2, 3. Lobes of the nephridium corresponding to those of Fig. D. in text. Bv. blood vessels. Nd. duct of nephridium close to its opening into the vesicle, vs. Nuc. nuclei in walls of the intracellular duct.

Fig. 21. Section across part of a nephridium showing the vesicle (vs.), lobes Neph. 1 and Neph. 2 and blood vessel giving off a branch Bv. 2 to the nephridium, the muscles in the wall of this branch being less strongly marked than in those of the main branch Bv. Drawn under Zeiss, C. oc. 2.

Fig. 22. Portion of lateral vessel to show strongly developed circular muscle fibres and the small longitudinal fibres. Drawn under Zeiss, F. oc. 2.

LIBRARY

Art. XXII.—*Catalogue of the Marine Shells of Victoria.*

Part I.

By G. B. Pritchard and J. H. Gatliff.

[Read 9th December, 1897.]

Introduction.

It may not be out of place, perhaps, if we give at the outset a brief account of previous work on this subject.

Most of the very early work may be found in the reports of the voyages of various exploring vessels, but these at present call for no special remark, references to them will be found in their proper places.

The Rev. J. E. T. Woods was early in the field; during the years 1875 to 1879 he contributed largely on the shells of Tasmania, and, as would naturally be expected, a large amount of the material dealt with can also be obtained in Victoria. What has become of many of his types is unfortunately unknown to us, and as most of his work was not illustrated it is generally a difficult matter to fix his species. In 1877 he furnished a very useful census of the Marine Shells of Tasmania and the adjacent islands, in which may be found several references to Victorian occurrences. In the same year, and again in 1880, he described a number of new species in the Transactions and Proceedings of the Royal Society of Victoria.

Although a great many of this gentleman's species have been relegated to synonymy, he must be credited with having done a great amount of useful work, particularly when the difficulty of obtaining access to the necessary works of reference is fully understood, and also the difficulty of interpreting wretchedly poor and meagre descriptions, frequently without figures or with figures that cannot possibly be recognised as representing the species, even by a stretch of the imagination.

In 1887 Mr. J. H. Gatliff published Part I. of a list of some of the Shells of the Marine Mollusca found upon the coast of

Victoria in the paper issued by our Field Naturalists' Club. In the following year the list was completed by the issue of Part II. The list was much needed, and supplied an undoubted want. It contained 351 species and 12 varieties, and some of the commoner synonyms. Its summary is as follows:—

Gastropoda - - -	260 species -	12 varieties
Polyplacophora - -	4 ,,	
Scaphopoda - - -	1 ,,	
Pelecypoda - - -	86 ,,	
Total	351 species	12 varieties

In 1887 also the late Mr. J. Bracebridge Wilson furnished a list to the Field Naturalists' Club of the species dredged by him in the neighbourhood of Port Phillip Heads. Most of the species were identified by Professor R. Tate and the list contains 142 species. As a member of the Port Phillip Biological Survey Committee of the Royal Society, Mr. Wilson did a vast amount of excellent collecting, and among the molluscan collection many interesting and new forms and several not previously recorded for Victoria have turned up. We have to thank Professor W. B. Spencer for kindly allowing us access to this material.

For other records of and references to Victorian shells we must draw attention to the various papers on the shells of the other colonies, published many years ago by Messrs. A. Adams and G. F. Angas; and more recently by Dr. Cox, Messrs. J. Brazier and C. Hedley of New South Wales; and Professor R. Tate, Mr. W. T. Bednall, and Dr. Verco of South Australia.

In the year 1891 one of the present authors was asked by Professor R. Tate of the Adelaide University to prepare a catalogue of Victorian Mollusca, and he very kindly allowed access to his own notes and records of the species then known to him. Since that time a good deal of revision has been done and a vast amount of material, both literary and otherwise, has been collected. We hope that in its present form the catalogue may prove useful to those interested in the shells of our waters.

In July of last year (1896) we had the pleasure of seeing Mr. E. R. Sykes's excellent report on Mr. J. B. Wilson's collection of Port Phillip Polyplacophora which includes the very respectable total of 22 species, with descriptions and figures of five new species. It is intended to issue the present catalogue in parts, and we hope to cover the ground in four parts of about the size of the present issue. We cannot yet with certainty give a summary of the whole catalogue, but the present part contains:—

Cephalopoda - - - -	12 species
Pteropoda - - - - -	11 ,,
Gastropoda - - - - -	62 ,,

At the conclusion of the fourth part a complete summary will be given. On account of the difficulty and occasionally the impossibility of obtaining access to many of the original papers and books on our shells our labour has been very much increased and frequently great trouble has arisen in settling questions of priority. Also when in doubt as to the interpretation of figures and descriptions we have felt very strongly the necessity for examining the types, and this very frequently we have been unable to do. We include references to the few types accessible to us for the benefit of other workers who may not know where they are located. There seems to be a very great necessity for a more general knowledge of the rules to be adhered to by all workers in zoological subjects. Endless trouble would be saved if consistent methods could in some way be enforced. As far back as 1864 a committee of the British Association for the Advancement of Science submitted a series of regulations for zoological work, which, if only attended to, should have had good results. More publicity should be given to the general rules accepted by zoologists, and if this were only done much needless confusion and perhaps some synonomy might frequently be saved.

We have to tender our sincerest thanks to Sir Frederick McCoy for the loan of the most important standard works, without which we would have been unable to do any satisfactory work, also for the readiness with which he has allowed us access to the molluscan specimens in the National Museum. We are also much indebted to Mr. W. Kershaw of the Museum for his kind attention and readiness to find what we required at any time.

We have also to thank Professor W. B. Spencer and Mr. T. S. Hall, M.A., for the loan of books, pamphlets, and specimens; and Mr. C. Hedley of the Australian Museum and

Dr. Verco of South Australia for much valuable information on conchological matters, and their ready compliance to any requests. Mr. Gabriel and his son, Mr. C. Gabriel, should receive our best thanks for many excellent specimens and some new species dredged by them in Western Port Bay.

BIBLIOGRAPHY AND LIST OF ABBREVIATIONS.

Amer. Jour. Conch.	American Journal of Conchology.
A.M.N.H.	Annals and Magazine of Natural History.
Ann. du Mus.	Annales du Muséum d'Histoire Naturelle, Paris.
Anim. S. Vert.	Histoire Naturelle des Animaux sans Vertèbres, Lamarck.
Astrolabe	Voyage de "l'Astrolabe," Quoy and Gaimard.
Cat. Austr. Mus.	Catalogue of the Marine Shells of Australia and Tasmania, Australian Museum, Sydney.
Cat. B.M.	Catalogue of the British Museum.
Cat. N.Z. Moll.	Catalogue of the Marine Mollusca of New Zealand, Hutton.
Ceph. Hamb. Mus.	Cephalopoda Hamburger Museums.
Chall.	Voyage of H.M.S. "Challenger."
Conch. Cab.	Conchylien Cabinet, Martini and Chemnitz.
Conch. Icon.	Conchologia Iconica, Reeve.
Conch. Illus.	Conchological Illustrations, Sowerby.
Dict. d. Sci. Nat.	Dictionnarie des Sciences Naturelles.
Encyc. Meth.	Encyclopedie Methodique, Paris, 1782-1824.
Icon. Coq. Viv.	Spécies Général et Iconographie des Coquilles Vivantes.
Index Test.	Index Testaceologicus, Wood, London.
Jour. Acad. Nat. Sci. Philad.	Journal of the Academy of Natural Science, Philadelphia.
Jour. d. Conch.	Journal de Conchyliologie, Paris.
Jour. of Conch.	Journal of Conchology, England.
J.L.S.	Journal of the Linnean Society, London.

Man. Conch.	Manual of Conchology, Philadelphia.
Man. N.Z. Moll.	Manual of the New Zealand Mollusca, Hutton.
Moll. Nov. Holl.	Molluscorum Novae Hollandiæ, Menke.
Mus. Gevers.	Museum Geversianum.
Nat. Hist. Miscell.	Natural History Miscellany.
Nouv. Ann. du Mus.	Nouvelles Annales du Muséum d'Histoire Naturelle, Paris.
Nouv. Arch. du Mus.	Nouvelles Archives du Muséum d'Histoire Naturelle, Paris.
Novara	Reise d. Novara, Frauenfield.
Otia Conch.	Otia Conchologica, Gould, Boston.
Portl. Cat.	Portland Catalogue, Solander.
P.L.S., N.S.W.	Proceedings of the Linnean Society of New South Wales.
P. Mal. S. Lond.	Proceedings of the Malacological Society of London.
P.R.S. Edin.	Proceedings of the Royal Society, Edinburgh.
P.R.S. Tas.	Proceedings of the Royal Society, Tasmania.
P.R.S. Vic.	Proceedings of the Royal Society, Victoria.
P.Z.S. Lond.	Proceedings of the Zoological Society, London.
Prod. Zoo. Vic.	Prodromus of the Zoology of Victoria, McCoy.
Samarang	Zoology of the Voyage of H.M.S. "Samarang."
Sudafr. Moll.	Sudafrikanischen Mollusken, Krauss.
Syst. Nat.	Systema Naturæ, Linnæus.
Thes. Conch.	Thesaurus Conchyliorum, Sowerby.
T.R.S., S.A.	Transactions of the Royal Society of South Australia.
T.R.S. Vic.	Transactions and Proceedings of the Royal Society of Victoria.
U.S. Expl. Exped.	United States Exploring Expedition.
Univ. Conch.	Universal Conchologist, Martyn.
V.N.	Victorian Naturalist.
Zeits. f. Mal.	Zeitschrift fur Malakozoologische, Cassel.

Class CEPHALOPODA.

Order DIBRANCHIATA.

Family OCTOPODIDAE.

Genus **Octopus**, Lamarck, 1799.

OCTOPUS SUPERCILIOSUS, Quoy et Gaimard.

1832. Octopus superciliosus, Q. and G. Astrolabe, vol. ii., p. 88, pl. 6, f. 4.
1838. Octopus westerniensis, Quoy. d'Orb. Céph. Acét., Poulpes, pl. 10, f. 3 (Brazier. Cat.)
1886. Octopus superciliosus, Hoyle. Chall. Zool., vol. xvi., p. 9, No. 16.

Hab.—Western Port, Bass Strait.

OCTOPUS BOSCII, Lesueur.

1821. Octopus boscii, Lesueur. Jour. Acad. Nat. Sci. Philad., vol. ii., p. 101.
1826. Octopus variolatus, Peron, Blainv. Dict. d. Sci. Nat., vol. xliii., p. 186.
1849. Octopus boscii, Gray. Cat. B.M., p. 12.
1886. Octopus boscii, var. pallida, Hoyle. Chall. Zool., vol. xvi., Cephalopoda, pp. 81, 82, pl. 1, pl. 2, f. 2.

Hab.—East Moncoeur Island, Bass Strait, 38 fath., sand and shells (Challenger). Port Phillip Heads (J. B. Wilson).

OCTOPUS AUSTRALIS, Hoyle.

1885. Octopus australis, Hoyle. A.M.N.H., ser. 5, vol. xv., p. 224; also P.R.S. Edin., vol. xiii., p. 98.
1886. Octopus australis, Hoyle. Chall. Zool., vol. xvi., Ceph., p. 88, pl. 3, f. 4, 5.

Hab.—Port Phillip Heads, dredged by Mr. J. B. Wilson.

Obs.—The type of this species was obtained by the Challenger Expedition in Port Jackson, 6 to 15 fathoms.

OCTOPUS DUPLEX, Hoyle.

1885. Octopus duplex, Hoyle. A.M.N.H., ser. 5, vol. xv., p. 226; P.R.S. Edin., vol. xiii., p. 101.

1886. Octopus duplex, Hoyle. Chall. Zool., vol. xvi., p. 90, pl. 7, f. 5.

Hab.—Elwood Beach, Port Phillip (Rev. W. Fielder).

Obs.—The type was obtained by the Challenger Expedition, off Twofold Bay.

Family ARGONAUTIDÆ.

Genus **Argonauta**, Linné, 1756.

ARGONAUTA NODOSA, Solander.

1786. Argonauta nodosa, Solander. Portl. Cat., 76, 2120, vol. ii., p. 113.

1786. Argonauta navicula, Solander. *Ibid.*, 42, 1055 (=forma aurita), vol. ii., p. 112.

1787. Argonauta oryzata, Meuschen. Mus. Gevers, 252, No. 133.

? 1790. Argonauta tuberculata, Shaw. Nat. Hist. Miscell., vol. xxiii., t. 995.

1822. Argonauta tuberculosa, Lamarck. Anim. S. Vert., vol. vii., p. 632.

1861. Argonauta tuberculosa, Reeve. Conch. Icon., pl. 1 (=forma mutica).

1879. Argonauta nodosa, Tryon. Man. Conch., vol. 1, p. 140, pl. 50, f. 124.

1886. Argonauta tuberculata, Hoyle. Chall. Zool., vol. xvi., p. 4, No. 2.

Hab.—Port Phillip Bay (not uncommon), Bass Strait, and coast generally at certain seasons.

Obs.—Although Hoyle gives Shaw's specific name priority, he at the same time mentions that he has been unable to ascertain beyond doubt when Shaw's work was published, for the volume bears no date. He further states that Dillwyn (*op. cit.*, p. xi.) gives 1790; if this be correct Solander's name should take precedence. As there is a doubt about the matter I prefer at present to use Solander's name. Mr. J. Brazier in his Catalogue of the Marine Shells of Australia and Tasmania, Part I., also uses the latter, but he does not include Victoria as a locality of its occurrence.

ARGONAUTA ARGO, Linné.

1758. Argonauta argo, Linn. Syst. Nat., ed. 10, p. 708.
1769. Nautilus papyraceus, Martini. Conch. Cab., vol. i, p. 231, pl. 17, f. 157, also p 238.
1835. Argonauta argo, d'Orb. Ceph. Acét., p. 158, pl. 2, f. 1, 2.
1861. Argonauta argo, Reeve. Conch. Icon., pl. 3, f. 2c, also A. haustrum, Reeve, *Id.*, pl. 2.
1872. Argonauta pacifica, Dall. Amer. Jour. Conch., vol. iii., p. 95.
1879. Argonauta argo, Tryon. Man. Conch., vol. i., p. 138, pl. 47, f. 111, 112, pl. 48, f. 116, 117.
1886. Argonauta argo, Hoyle. Chall. Zool., vol. xvi., pp. 4, 69.

Hab.—Lakes Entrance, Gippsland.

Obs.—For additional synonymy and further references, Mr. J. Brazier's Catalogue of the Marine Shells of Australia and Tasmania, Part I., Cephalopoda, 1892, may be consulted.

Family OMMATOSTREPHIDÆ.

Genus **Ommatostrephes**, d'Orbigny, 1835 (Ommastrephes).

OMMATOSTREPHES GOULDI, McCoy.

1888. Ommastrephes gouldi, McCoy. Prod. Zoo. Vic., Dec. xvii., pl. 169, 170.

Hab.—Victorian waters (McCoy).

Family SEPIOLIDÆ.

Genus **Inioteuthis**, Verrill, 1881.

INIOTEUTHIS TASMANICA, Pfeffer.

1884. Sepiola tasmanica, Pfeffer. Ceph. Hamb. Mus., p. 6, f. 7.
1886. Sepiola tasmanica, Hoyle. Chall. Zool., vol. xvi., p. 17.
1892. Inioteuthis tasmanica, Brazier. Cat. Austr. Mus., pt. i., p. 9.

Hab.—Bass Strait.

Family LOLIGINIDÆ.

Genus **Sepioteuthis**, Blainville, 1825.

SEPIOTEUTHIS AUSTRALIS, Quoy et Gaimard.

1832. Sepioteuthis australis, Q. and G. Astrolabe, Zool. vol. ii., p. 77, pl. 4, f. 1.

1883. Sepioteuthis australis, McCoy. Prod. Zoo. Vic., Dec. viii., pl. 76-77.

1886. Sepioteuthis australis, Hoyle. Chall. Zool., vol. xvi., Ceph., pp. 26, 220.

Hab.—Western Port (Q. and G.). Port Phillip Bay (McCoy).

SEPIOTEUTHIS BILINEATA, Quoy et Gaimard.

1832. Sepioteuthis bilineata, Q. and G. Astrolabe Zool., vol. ii., p. 66, pl. 2, f. 1.

1886. Sepioteuthis bilineata, Hoyle. Chall. Zool., vol. xvi., Ceph., p. 27.

Hab.—Western Port, Bass Strait (Q. and G.).

Family SEPIIDÆ.

Genus **Sepia**, Linné, 1766.

SEPIA APAMA, Gray.

1849. Sepia apama, Gray. Ceph. Antep. B.M., p. 103, No. 10.

1886. Sepia apama, Hoyle. Chall. Zool., vol. xvi., Ceph., p. 24.

1888. Sepia apama, McCoy. Prod. Zoo. Vic , Dec. xix., pl. 188, 189, 190.

Hab.—Victorian waters (McCoy).

Family SPIRULIDÆ.

Genus **Spirula**, Lamarck, 1801.

SPIRULA AUSTRALIS,, Lamarck.

1816. Spirula australis, Lamarck. Encyc. Meth., pl. 465, f. 5a.

1848. Spirula australis, Owen. Samarang, Moll., pt. i., pp. 6-17, pl. 4.

1849. Lituus laevis, Gray. Ceph. Antep. B.M., p. 115.

1879. Spirula australis, Owen. A.M.N.H., ser. 5, vol. iii., pp. 1-16, pls. 1-3.
1880. Spirula australis, Owen. P.Z.S. Lond., p. 352, pl. 32.
1895. Spirula australis, Huxley and Pelseneer. Chall. Zool., pt. lxxxiii. Appendix to Summary, pt. ii., pl. 2, figs. 1-3.

Hab.—Heytesbury Coast, several examples (T. S. Hall).

Class GASTROPODA.

Order OPISTHOBRANCHIATA.

Sub-Order PTEROPODA.*

Section THECOSOMATA

Family LIMACINIDAE.

Genus **Limacina**, Cuvier, 1817.

LIMACINA INFLATA, d'Orbigny.

1836. Atlanta inflata, d'Orbigny. Voy. dans l'Amérique méridionale, vol. v., p. 174, pl. 12, f. 16-19.
1840. Spirialis rostralis, Eydoux et Souleyet. Description sommaire de plusieurs Ptéropodes nouveaux ou imparfaitement connus, Revue Zoologique, vol. iii., p. 236.
1850. Limacina inflata, Gray. Cat. Moll. B.M., pt. ii., Pteropoda, p. 31.
1852. Spirialis rostralis, Eydoux et Souleyet. Voy. de la Bonite, Zoologie, vol. ii., p. 216, pl. 13, f. 1-10.
1852. Limacina scaphoidea, Gould. The Mollusca and Shells of the U.S. Exploring Expedition, p. 485, pl. 51, f. 602.
1861. Protomedea elata, O. G. Costa. Microdoride mediterranea, p. 74, pl. 11, f. 5.

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*The Pteropoda are now generally accepted as a sub-order of the Gastropoda; and should therefore hardly have been included in this part of the Catalogue, but should have been held over for inclusion with the Opisthobranchiata, but as the material, so far as it is at present known to us, was all in readiness, it was found convenient to incorporate it with this part.

1870. Embolus rostralis, Jeffreys. Mediterranean Mollusca, A.M.N.H., ser. 4, vol. vi., p. 86.

1882. Protomedea rostralis, Fischer. Sur la faune Malacologique abyssale de la Mediterranée, Comptes rendus, vol. xciv., p. 120.

1888. Limacina inflata, Pelseneer. Chall. Zool., vol. xxiii., Pteropoda, p. 16.

Hab.—Melbourne to Sydney (Challenger).

LIMACINA LESUEURI, d'Orbigny.

1836. Atlanta lesueuri, d'Orbigny. Voy. dans l'Amérique méridionale, vol. v., p. 177, pl. 20, f. 12-15.

1836. Atlanta rangii, d'Orbigny. *L.c.*, p. 176, pl. 12, f. 25-28.

1840. Spirialis ventricosa, Eydoux et Souleyet. Revue Zoologique, vol iii., p. 236.

1850. Limacina ventricosa, Gray. Cat. Moll. B M., pt. ii., Pteropoda, p. 32.

1852. Spirialis ventricosa, Eydoux et Souleyet. Voy. de la Bonite, Zoologie, vol. ii., p. 216, pl. 13, f. 11-16.

1886. Limacina lesueuri, Boas. Spolia Atlantica, p. 46, pl. 3, f. 33, 34.

1888. Limacina lesueuri, Pelseneer. Chall. Zool., vol. xxiii., Pteropoda, pp. 24, 25.

Hab.—Melbourne to Sydney (Challenger).

LIMACINA TROCHIFORMIS, d'Orbigny.

1836. Atlanta trochiformis, d'Orbigny. *Op. cit.*, vol. v., p. 177, pl. 12, f. 29-31.

1840. Spirialis trochiformis, Eydoux et Souleyet. Revue Zoologique, vol. iii., p. 237.

1850. Limacina trochiformis, Gray. Cat. Moll. B.M., pt. ii., Pteropoda, p. 33.

1852. Limacina naticoides, Rang. Hist. Nat. des Moll., Pteropodes, pl. 10, f. 1, 2.

1852. Spirialis trochiformis, Eydoux et Souleyet. Voy. de la Bonite, Zoology, vol. ii., p. 223, pl. 13, f. 27-34.

1888. Limacina trochiformis, Pelseneer. Chall. Zool., vol. xxiii., Pteropoda, pp. 29, 30.

Hab.—Melbourne to Sydney (Challenger).

LIMACINA BULIMOIDES, d'Orbigny.

1836. Atlanta bulimoides, d'Orbigny. *Op. cit.*, vol. v., p. 179, pl. 12, f. 36-38.

1840. Spirialis bulimoides, Eydoux et Souleyet. Revue Zoologique, vol. iii., p. 238.

1850. Limacina bulimoides, Gray. Cat. Moll. B.M., pt. ii., Pteropoda, p. 34.

1852. Spirialis bulimoïdes, Eydoux et Souleyet. Voy. de la Bonite, Zoologie, vol. ii., p. 224, pl. 13, f. 35-42.

1877. Heterofusus bulimoides, Angas. P.Z.S. Lond., p. 99.

1888. Limacina bulimoides, Pelseneer. Chall. Zool., vol. xxiii., Pteropoda, pp. 30-32.

Hab.—Melbourne to Sydney (Challenger).

Family CAVOLINIIDÆ.

Genus **Clio**, Linné, 1767.

CLIO (CRESEIS) VIRGULA, Rang.

1828. Creseis virgula, Rang. Ann. d. Sci. Nat., sér 1., vol. xiii., p. 316, pl. 17., f. 2.

1829. Creseis unguis, Eschscholtz. Zoologischer Atlas Heft. iii., p. 17, pl. 15, f. 4.

1829. Creseis cornucopiæ, Eschscholtz. *Ibid.*, p. 17, pl. 15, f. 5.

1829. Creseis caligula, Eschscholtz. *Ibid.*, p. 18, pl. 15, f. 6.

1836. Hyalæa corniformis, d'Orbigny. *Op. cit.*, vol. v., p. 120, pl. 8, f. 20-23.

1850. Styliola virgula, Gray. Cat. Moll. B.M., pt. ii., Pteropoda, p. 17.

1850. Styliola corniformis, Gray. *Ibid.*, p. 18.

1852. Cleodora virgula, Souleyet. Voy. de la Bonite, Zoologie, vol. ii., p. 196, pl. 8, f. 18-25.

1852. Cleodora munda, Gould. Moll. U.S. Explor. Exped., p. 489, pl. 51, f. 607.
1852. Cleodora placida, Gould. *Ibid.*, p. 489, pl. 51, f. 606.
1852. Cleodora falcata, Gould. *Ibid.*, p. 490, pl. 51, f. 608.
1879. Cleodora flexa, Pfeffer. Monatsber, d.k. preuss. Akad. d. Wiss. Berlin, p. 241, f. 15-16.
1888. Clio (Creseis) virgula, Pelseneer. Chall. Zool., vol. xxiii., Pteropoda, p. 48.

Hab.—Melbourne to Sydney (Challenger).

CLIO (STYLIOLA) SUBULA, Quoy and Gaimard.

1825. Styliola recta, Lesueur, in de Blainville. Man. de Malac, p. 655 (nomen tantum).
1827. Cleodora subula, Quoy and Gaimard. Ann. de Sci. Nat., sér. 1, vol. x., p. 233, pl. 8D, f. 1-3.
1828. Creseis spinifera, Rang. Ann. d. Sci. Nat., sér. 1, vol. xiii., p. 313, pl. 17, f. 1.
1828. Creseis subula, Rang. *Ibid*, pl. 18, f. 1.
1836. Hyalæa subula, d'Orbigny. *Op. cit.*, vol. v., p. 119, pl. 8, f. 15-19.
1850. Styliola subula, Gray. Cat. Moll. B.M., pt. ii., Pteropoda, p. 17.
1852. Cleodora subulata, Eydoux and Souleyet. Voy. de la Bonite, Zoologie, vol. ii., p. 191, pl. 8, f. 5-9.
1886. Cleodora subula, Boas. Spolia Atlantica, pp. 66, 202, pl. 4, f. 44, 45.
1888. Clio (Styliola) subula, Pelseneer. Chall. Zool., vol. xxiii., Pteropoda, p. 57.

Hab.—Off Melbourne (Challenger).

CLIO PYRAMIDATA, Linné.

1767. Clio pyramidata, Linné. Syst. Nat., ed. 12, p. 1094.
1813. Hyalæa lanceolata, Lesueur. Nouv. Bull. Soc. Philom. Paris, vol. iii., p. 284, pl. 5, f. 3.
1825. Cleodora brownii, de Blainville. Man. de Malac., pl. 46, f. 1.

1836. Hyalæa pyramidata, d'Orbigny. *Op. cit.*, vol. v., p. 113, pl. 7, f. 25-29.
1841. Cleodora lamartinieri, Rang., in d'Orbigny. Mollusques de Cuba, p. 83.
1852. Cleodora lanceolata, Eydoux et Souleyet. Voy. de le Bonite, Zool. vol. ii., p. 179, pl. 6, f. 17-25.
1852. Cleodora exacuta, Gould. Moll., U.S. Expl. Exp., p. 488, pl. 51, f. 605.
1877. Cleodora labiata. Sowerby in Reeve Conch. Icon., vol. xx., Pteropoda, f. 26.
1880. Cleodora martensii, Pfeffer. Abhandl. d. Naturw. Ver Hamburg, bd. vii., p. 95, pl. 7, f. 16.
1886. Cleodora pyramidata, Boas. Spolia Atlantica, p. 69, pl. 6, f. 96, 97.
1888. Clio pyramidata, Pelseneer. Chall. Zool., vol. xxiii., pteropoda, pp. 63-65.

Hab.—Off Melbourne (Challenger).

Obs.—For description and figures of the preceeding species of this class, Pelseener refers to the work of Eydoux and Souleyet in the Zoology of the Voyage de la Bonite. This work can be seen in the Melbourne Public Library.

For the succeeding species the same authority refers for description and figures to Boas' Spolia atlantica.

Genus **Cavolinia**, Giveni, 1783.

CAVOLINIA LONGIROSTRIS, Lesueur.

1821. Hyalæa longirostris, Lesueur. M.S. in de Blainville, Hyale, Dict. d. Sci. Nat., vol. xxii., p. 81.
1821. Hyalæa ecaudata, Lesueur. *Ibid*, p. 82.
1836. Hyalæa limbata, d'Orbigny. Voy. d. l'Amer. Mérid, vol. v., p. 101, pl. 6, f. 11-15.
1852. Hyalæa angulata, Eydoux et Souleyet. Voy. de la Bonite, Zool., vol. ii., p. 152, pl. 5, f. 1-6.
1852. Hyalæa femorata, Gould. Moll., U.S. Expl. Exp., pl. 51, f. 603.
1861. Hyalæa fissirostris, Benson. Ann. and Mag. Nat. Hist., ser. 3, vol. 7, p. 26.
1877. Hyalæa obtusa, Sowerby. In Reeve, Conch. Icon. vol. xx., Pteropoda, f. 8.

1886. Hyalæa longirostris, Boas. Spolia Atlantica, p. 102, pl. 1, f. 5; pl. 2, f. 16.

1888. Cavolinia longirostris, Pelseneer. Chall. Zool., vol. xxiii., Pteropoda, pp. 79-81.

Hab.—Melbourne to Sydney (Challenger).

CAVOLINIA GIBBOSA, Rang.

1836. Hyalæa gibbosa, Rang., M.S., in d'Orbigny. Voy. d. l'Amér. Mérid., vol. v., p. 95, pl. 5, f. 16-20.

1836. Hyalæa flava, d'Orbigny. *Ibid.*, p. 97, pl. 5, f. 21-25.

1852. Hyalæa gibbosa, Eydoux et Souleyet. Voy. de la Bonite, Zool., vol. ii., p. 144, pl. 4, f. 13-19.

1880. Hyalæa gegenbauri, Pfeffer. Abhandl. Naturw. Ver. Hamburg, bd. vii., p. 86, f. 5-7.

1886. Hyalæa gibbosa, Boas. Spolia Atlantica, p. 109, pl. 1, f. 6; pl 2, f. 17.

1888. Cavolinia gibbosa, Pelseneer. Chall. Zool., vol. xxiii., Pteropoda, p. 82.

Hab.—Melbourne to Sydney (Challenger).

CLEODORA COMPRESSA, Eydoux et Souleyet.

1850. Clio depressa, Gray. Cat. Moll. B.M., pt. ii., Pteropoda, p. 14 (sine descriptione).

1852. Cleodora compressa, Eydoux et Souleyet. Voy. de la Bonite, Zool., vol. ii., p. 181, pl. 6, f. 26-32.

1888. Cleodora compressa, Pelseneer. Chall. Zool., vol. xxiii., Pteropoda, pp. 87, 88.

Habs.—Melbourne to Sydney (Challenger).

Obs.—Pfeffer originally suggested that this species was a young form of Cavolinia trispinosa, but Boas objected to this view. Pelseneer agrees with Pfeffer and enters fully into his reasons for so doing in Challenger Zoology, vol. xxiii., p. 87. For further information for those interested I therefore append a copy of the synonymy of Cavolinia trispinosa, Lesueur.

CAVOLINIA TRISPINOSA, Lesueur.

1821. Hyalæa trispinosa, Lesueur. M.S., in de Blainville, Dict. d. Sci. Nat., vol. xxii., p. 82.

1827. Hyalæa mucronata, Quoy and Gaimard. Ann. d. Sci. Nat., sér. 1, vol. x., p. 231, pl. 8B., f. 1, 2.

1832. Hyalæa depressa, Bivona. Effemeridi scientifiche e litterarie per la Sicilia, p. 57, pl. 1, f. 4, 5.

1841. Hyalæa cuspidata, Delle Chiaje, Descrizione e notomia degli animali senza vertebre del Regno di Napoli, pl. 180, f. 1, 2 (non. d'Orbigny).

1850. Diacria trispinosa, Gray. Cat. Moll. B.M., pt. ii., Pteropoda, p. 10.

1850. Diacria mucronata, Gray. *Ibid.*, p. 11.

1853. Hyalæa reeviana, Dunker. Index Molluscorum, p. 2, pl. 1., f. 17-20.

1858. Pleuropus trispinosus, H. and A. Adams. Gen. Rec. Moll., vol. ii., p. 611.

1858. Pleuropus mucronatus, H. and A. Adams. *Ibid.*, vol. ii., p. 611.

1886. Hyalæa trispinosa, Boas. Spolia Atlantica, p. 94, pl. 1, f. 3; pl. 2, f. 14.

1888. Cavolinia trispinosa, Pelseneer. Chall. Zool., vol. xxiii., Pteropoda, pp. 76-78.

CUVIERIA MINOR, McCoy.

1885. Cuvieria minor, McCoy. Prod. Zoo. Vic., vol. ii., Dec xi., p. 13.

Class GASTROPODA.

Order PROSOBRANCHIATA.

Sub-Order PECTINIBRANCHIATA.

Family MURICIDÆ.

Genus **Murex**, Linné, 1758.

MUREX (PTERONOTUS) TRIFORMIS, Reeve.

1845. Murex triformis, Reeve. P.Z.S. Lond., p. 87.

1845. Murex triformis, Reeve. Conch. Icon., vol. iii., pl. 13, f. 53.

1876. Murex zonatus, T. Woods. P.R.S. Tas., p. 132.

1878. Murex triformis, Kuster. Conch. Cab., 2nd ed., p. 85, pl. 30, f. 4.
1879. Murex triformis, Sowerby. Thes. Conch., vol. iv., p. 21, pl. 10 (Murex), f. 92; pl. 13. f. 126.
1880. Murex triformis, Tryon. Man. Conch., vol. ii., p. 85, pl. 40, f. 511.

Hab.—Common in Port Phillip, and shores of Victoria generally. Dredged alive off East Moncoeur Island, Bass Strait, 38 fathoms, sand and shells (Challenger); about 3 fathoms off Brighton, and 5 fathoms off Point Cooke.

MUREX (PTERONOTUS) ANGASI, Crosse.

1863. Typhis angasi, Crosse. Jour. d. Conch., vol. ii., p. 86, pl. 1, f. 2.
1867. Murex (Pteronotus) angasi, Angas. P.Z.S. Lond., p. 186, No. 5.
1873. Murex (Pteronotus) eos, Hutton. Cat. N.Z. Moll., p. 8.
1878. Murex eos, Hutton. Jour. d. Conch., vol. xviii., 3rd ser., p. 12.
1879. Murex angasi, Sowerby. Thes. Conch., vol. iv., p. 26, pl. 21, Murex, f. 189, 190.
1880. Murex (Pteronotus) angasi, Tryon. Man. Conch., vol. ii., p. 88, pl. 40, f. 522.
1880. Murex (Pteronotus) angasi, Hutton. N.Z. Moll., p. 47.
1883. Murex (Pteronotus) cordismei, Watson. J.L.S. Lond., vol. xvi., p. 601.
1886. Murex (Pteronotus) cordismei, Watson. Chall. Zool., vol. xv., p. 156, pl. 10, f. 5.

Hab.—Shores of Victoria (J. Brazier, Prof. R. Tate). Off East Moncoeur Island, Bass Strait, 38 fathoms, sand and shells (Challenger). Polwarth Coast, San Remo, and Flinders. Dredged alive off Altona Bay in about 5 fathoms.

Obs.—After a careful examination of Mr. Watson's figure and description of M. cordismei, we have come to the conclusion that it is undoubtedly the same as M. angasi, and therefore refer to it as above.

MUREX (CHICOREUS) AUSTRALIS, Quoy and Gaimard.

1833. Murex australis, Quoy and Gaimard. Astrolabe Zool., vol. ii., p. 536.

1840. Murex palmiferus, Sowerby. P.Z.S. Lond., p. 142, also, Conch. Illust., sp. 43, f. 104.

1845. Murex palmiferus, Reeve. Conch. Icon., vol. iii., pl. 4, f. 20.

1879. Murex palmiferus, Sowerby. Thes. Conch., p. 18, sp. 84, pl. 4, f. 41.

1880. Murex (Chicoreus) palmiferus, Tryon. Man. Conch., vol. ii., p. 90, pl. 14, f. 146.

1880. Murex (Tribulus) australis, Tryon. *Ibid*, p. 83.

1882. Murex (Chicoreus) australis, Poirier. Nouv. Arch. du Mus. d'Hist. Nat., 2e sér., vol ii., p. 32, No. 4.

1886. Murex (Chicoreus) palmiferus, Watson, Chall. Zool., vol. xv., p. 155.

1893. Murex (Chicoreus) palmiferus, Brazier. P.L.S., N.S.W., vol. viii., pt. i., 2nd. ser., p. 113 *et seq.* Cat. Austr. Mus., p. 60.

Hab.—Western Port (Q. and G., 1829). Cowes (T. S. Hall). Off East Moncoeur Island, Bass Strait, 31 fathoms, sand and shells (Challenger); Port Phillip Heads (J. B. Wilson); Port Melbourne; Airey's Inlet.

MUREX (OCINEBRA) BRAZIERI, Angas.

1877. Murex brazieri, Angas. P.Z.S. Lond., p. 171, pl. 26, f. 3.

1879. Murex brazieri, Sowerby. Thes. Conch., vol. iv., p. 42, sp. 200, Murex, pl. 33, f. 226.

1880. Murex (Ocinebra) brazieri, Tryon. Man. Conch., vol. ii., p. 132, pl. 30, f. 289.

1882. Murex (Muricidea) brazieri, Poirier. Nouv. Arch. du Mus. d'Hist. Nat., 2e sér., vol. v., p. 104, No. 208.

1884. Trophon tumida, Petterd. Jour. of Conch., vol. iv., pt. 5, p. 141, No. 26.

1893. Murex (Ocinebra) brazieri, Brazier. P.L.S., N.S.W., 2nd ser., vol. viii., pt. i., pp. 117, 118.

Hab.—Port Melbourne, and Flinders, Western Port.

MUREX PLANILIRATUS, Reeve.

1845. Murex planiliratus, Reeve. Conch. Icon., vol. iii., pl. 31, f. 149.

1879. Murex planiliratus, Sowerby. Thes. Conch., vol. iv., p. 49, Murex, pl. 24, f. 264.

1880. Coralliophila costularis, Tryon (non Lamarck). Man. Conch., vol. ii., p. 208, pl. 65, f. 366.

Hab.—West Head, Western Port. One worn specimen only found (J. H. Gatliff).

MUREX UMBILICATUS, T. Woods.

1853. Murex scalaris, A. Adams (non Brocchi). P.Z.S. Lond., p. 71.

1875. Trophon umbilicatus, T. Woods. P.R.S. Tas., p. 135.

1880. Murex (Phyllonotus) angasi, Tryon (non Crosse). Man. Conch., vol. ii., p. 109.

1893. Murex umbilicatus, Brazier. Cat. Austr. Mus., pt. 3, p. 64, and P.L.S., N.S.W., vol. viii., pt. 1, 2nd ser., p. 116.

1896. Murex umbilicatus, Verco. T.R.S., S.A., p. 231, pl. 7, f. 4a, b, c.

Hab.—San Remo and Flinders; Jan Juc Coast and Airey's Inlet.

Obs.—Considerable confusion has surrounded this species on account of wrongful identifications. We have not referred to the whole of these, but have taken the above as sufficient. A consultation of those given will we venture to hope cover the ground and clear up the difficulties.

MUREX ENDIVIA, Lamarck.

1822. Murex endivia, Lam. Anim. S. Vert., vol. vii., p. 168.

1827. Murex endivia, Crouch. Lam. Conch., pl. 18, f. 1.

1842. Murex endivia, Kiener. Icon. Coq. Viv., p. 52, pl. 35, f. 1.

1843. Murex endivia, Lam. Anim. S. Vert. (Deshayes ed.), vol. ix., p. 583.

1845. Murex endivia, Reeve. Conch. Icon., vol. iii., pl. 7, f. 27b, c, d.

1845. Murex endivia, Kuster. Conch. Cab., 2nd ed., p. 42, pl. 17, f. 7.

1879. Murex endivia, Sowerby. Thes. Conch., vol. iv., p. 32; Murex, pl. 16, f. 153, 154.

1880. Murex (Phyllonotus) endivia, Tryon. Man. Conch., vol. ii., p. 102, pl. 26, f. 227-229.

Hab.—Portland Bay.

Obs.—There is no doubt that the specimen in Mr. Gatliff's collection was found at Portland Bay, but as yet no further examples of this species have been obtained in the colony. It is our opinion that this species does not properly belong to our colony and that the solitary representative may possibly have got to Portland Bay accidentally through the agency of man. Before we can accept this as a Victorian shell we wish to see more examples.

Genus **Typhis**, Montfort, 1810.

TYPHIS CLERYI, Sowerby.

1866. Typhis cleryi, Sowerby (non Petit). Thes. Conch., vol. iii., p. 320, pl. 284, f. 14.

1874. Typhis cleryi, Reeve. Conch. Icon., vol. xix., pl. 3, f. 11.

1880. Typhis cleryi, Tryon. Man. Conch., vol. ii., p. 137, pl. 30, f. 302.

1883. Typhis philippensis, Watson. Prelim. Rep., pt. xv., J.L.S. Lond., vol. xvi., p. 605.

1886. Typhis philippensis, Watson. Chall. Zool., vol. 15, p. 162, pl. 10, f. 4.

1893. Typhis cleryi, Brazier. Cat. Austr. Mus., p. 73.

Hab.—Off the entrance to Port Phillip, Melbourne, 33 fathoms, sand (Challenger).

Obs.—We agree with Mr. J. Brazier that the Sydney shell under the name of T. cleryi, Sowerby, is identical with that named by Mr. Boog Watson as T. philippensis.

TYPHIS ARCUATUS, Hinds.

1843. Typhis arcuatus, Hinds. P.Z.S. Lond., p. 19, and Voy. Sulphur, Mollusca, p. 10, pl. 3, f. 1, 2.

1862. Typhis japonicus, A. Adams. P.Z.S. Lond., p. 374.

1866. Typhis arcuatus, Sowerby. Thes. Conch., vol. iii., p 320, pl. 284, f. 3, 4, 5
1874. Typhis arcuatus, Reeve. Conch. Icon., vol. xix., pl. 3, f. 10.
1876. Typhis arcuatus, T. Woods. P.R.S. Tas., p. 132.
1877. Typhis arcuatus, Kobelt. Jahrb. d. deutsch. Malak. Gesell., vol. iv., p. 289.
1880. Typhis arcuatus, Tryon. Man. Conch., vol. ii., p. 136, pl. 30, f. 293.
1893. Typhis arcuatus, Brazier. Cat. Austr. Mus., pt. iii., p. 72.

Hab.—Jan Juc Coast, collected by the late J. F. Bailey.

TYPHIS YATESI, Crosse.

1865. Typhis yatesi, Crosse. Jour. d. Conch., p. 54, pl. 2. f. 3.
1866. Typhis yatesi, Sowerby. Thes. Conch., p. 284, f. 20, 21.
1880. Typhis yatesi, Sowerby. Thes. Conch., pl. 2, f. 22, 23.
1880. Typhis yatesi, Tryon. Man. Conch., p. 137, pl. 30, f. 294.
1895, Typhis yatesi, Verco. T.R.S., S.A., p. 97, pl. 2, f. 6.

Hab.—Dredged in Western Port Bay by Mr. J. Gabriel.

Genus **Trophon**, Montfort, 1810.

TROPHON PETTERDI, Crosse.

Trophon petterdi, Brazier, m.s.
1870. Trophon petterdi, Crosse, Jour. d. Conch., vol. x., p. 303.
1871. Trophon petterdi, Crosse. *Id.*, vol. xi., p. 324, pl. 12, f. 2.
1875 Trophon clathratus, T. Woods. P.R.S. Tas., p. 135.
1878. Trophon petterdi, Kobelt. Conch. Cab., vol. iii., p. 300, No. 30, pl. 75, f. 9, 10.
1879. Murex petterdi, Sowerby. Thes. Conch., p. 48, sp. 224, pl. 24, f. 255.

1880. Trophon petterdi, Tryon. Man. Conch., p. 148, pl. 33, f. 361.

Hab.—Port Phillip and coast generally.

Obs.—Sowerby's figure of this species is very bad, but the description agrees with our shell, and Tryon's figure is worse than useless.

TROPHON BRAZIERI, T. Woods.

1875. Trophon brazieri, T. Woods. P.R.S. Tas., p. 136.
1876. Siphonalia castanea, T. Woods. P.R.S. Tas., p. 139.
1880. Trophon brazieri, Tryon. Man. Conch. pp. 148, 156.

Hab.—Sandringham; Flinders, Western Port.

TROPHON GOLDSTEINI, T. Woods.

1875. Trophon goldsteini, T. Woods. P.R.S. Tas., p. 136.
1880. Trophon goldsteini, Tryon. Man. Conch., pp. 148, 156.
1895. Trophon goldsteini, Verco. T.R.S., S.A., vol. xix., p. 97, pl. 1, f. 4, 4a, 5.

Hab.—Dredged at Pt. Phillip Heads (J. B. Wilson); Flinders, Western Port.

TROPHON FLINDERSI, Adams and Angas.

1863. Purpura flindersi, Adams and Angas. P.Z.S. Lond., p. 421, pl. 37, f. 22.
1880. Trophon flindersi, Tryon. Man. Conch., vol. ii., p. 150, pl. 33, f. 357.
1895. Trophon laevis, Verco. T.R.S., S.A., p. 87, pl. 2, f. 5, 5a.

Hab.—Port Fairy.

TROPHON PAIVÆ, Crosse.

1864. Trophon paivæ, Crosse. Jour. d. Conch., vol. xii., p. 278, pl. 11, f. 7.
1873. Fusus corticatus, Hutton. Cat. N.Z. Moll., p. 9.
1876. Trophon assisi, T. Woods. P.R.S. Tas., p. 132.
1878. Trophon paivæ, Kobelt. Conch. Cab., vol. iii., p. 299, No. 28, pl. 71, f. 11.
1880. Trophon paivæ, Hutton. N.Z. Moll., p. 49.

1880. Urosalpinx paivæ, Tryon. Man. Conch., vol. ii., p. 155, pl. 39, f. 495.
1895. Trophon paivæ, Verco. T.R.S., S.A., p. 98, pl. 3, f. 2.

Hab.—Port Phillip, Western Port, and coast generally.

Obs.—Dr. Verco says T. assisi, T. Woods, is a distinct species from T. paivæ, Crosse. We however have not seen sufficiently good and constant characters in our examples of T. assisi to regard it as a good species. We have seen shells from South Australia and Tasmania which seem to conform well to T. Woods' description of T. australis; it is closely related to T. paivæ, but presents some differential characters which incline us to the opinion that it may possibly be conveniently regarded as a species, but if a large series be studied it may perhaps be found necessary to include it as but another variation of T. paivæ.

TROPHON EBURNEA, Petterd.

1884. Trophon eburnea, Petterd. Jour. of Conch., p. 142, sp. 27.

Hab.—Flinders, Western Port.

Obs.—This shell was removed to Tritonidea by Mr. Adcock in his list of South Australian Mollusca, but the change does not seem to be warranted by the characters displayed by the shell, our specimens not showing any columellar ridges or posterior tubercle, nor is the outer lip thick, and it is a distinctly umbilicate shell. Triton speciosa, Angas, from Port Jackson seems to be closely related generically, and also Murex borealis, Reeve, but we are not yet satisfied as to the best generic position.

Genus **Purpura**, Bruguière, 1789.

PURPURA SUCCINCTA, Martyn.

1784. Buccinum succinctum, Martyn. Univ. Conch., vol. ii., pl. 45.
1788. Buccinum orbita, Gmelin. P. 3490, No. 183.
Buccinum orbita, Chemnitz. Conch. Cab., vol. x., p. 199, pl. 154, f. 1471, 1472.
Purpura succincta, Lamarck. Anim. S. Vert., 2 ed., vol. x., p. 62, No. 5.

1822. Purpura textiliosa, Lamarck. Anim. S. Vert., vol. vii., No. 24, 2 ed.; vol. x., p. 77, No. 24.
1832.—Purpura textilosa, Blainville. Pourp. Nouv., Ann. de Mus., vol. i., p. 249, No. 98.
1833. Purpura textiliosa, Quoy and Gaimard. Astrolabe Zool., vol. ii., p. 552, pl. 37, f. 1-3.
Purpura succincta, Kiener. Coq. Viv. Purpura, p. 105, No. 66, pl. 27, f. 73.
Purpura textiliosa, Kiener. *Id.*, p. 104, No. 65, pl. 27, f. 72.
1846. Purpura textiliosa, Reeve. Conch. Icon., vol. iii., Purpura; No. 66, pl. 12, f. 66.
1846. Purpura succincta, Reeve. *Id.*, No. 23, pl. 5, f. 23.
1858. Purpura textiliosa, Chemnitz. Conch. Cab. (ed. Kuster), No. 29, p. 122, pl. 21, f. 9.
1858. Purpura succincta, Chemnitz. *Id.*, p. 124-5, No. 31, pl. 22, f. 9, 10, pl. 22a, f. 2.
1880. Purpura succincta, Hutton. N.Z. Moll., p. 56.

Hab.—Common in Port Phillip and along the coast generally.

Obs.—There seems to be no doubt whatever, that P. succincta and P. textiliosa are but variations of the one species. The nature of their habitat probably controlling their variations to a great extent. The finer ornamented form is the commoner with us.

PURPURA BAILEYANA, T. Woods,

1881. Purpura baileyana, T. Woods. T.R.S. Vic., vol. 17, p. 80, f. 1, 2.

Hab.—Schnapper Point, Port Phillip, locality of type; Flinders, Western Port; Puebla coast.

Obs.—The figure of this species is a very bad representation of the shell, but as the type is in the National Museum, Melbourne, we have been able to compare our specimens with it.

Genus **Sistrum**, Montfort, 1810.

SISTRUM ADELAIDENSIS, Crosse and Fischer.

1865. Ricinula adelaidensis, Crosse and Fischer. Jour. d. Conch., vol. xiii., p. 50, pl. 2, f. 1.

1875. Purpura littorinoides, T. Woods. P.R.S. Tas., p. 135.
1876. Purpura propinqua, T. Woods. P.R.S. Tas., p. 135.
1878. Cominella albolirata, T. Woods. P.R.S. Tas., p. 33.
1880. Ricinula adelaidensis, Tryon. Man. Conch., vol. ii., p. 189, pl. 59, f. 273.

Hab.—Flinders, Western Port, and Port Phillip; very common on the rocks between tide marks.

Obs.—After careful examination we have come to the conclusion that the above species of the late Rev. J. E. T. Woods are synonymous with Messrs. Crosse and Fischer's species. Where the types of P. littorinoides, and P. propinqua are, we do not know, but judging by the descriptions there is no doubt they fall in here. The type of Cominella albolirata, T. Woods, is however in the National Museum, Melbourne, and from an examination of it we have no doubt about it being a well preserved form of the above species. The shells labelled P. littorinoides in the National Museum agree with the above determination.

SISTRUM RETICULATUM, Quoy and Gaimard.

1832. Purpura reticulata, Quoy and Gaimard. Blainville, Nouv. Ann. du Mus., vol. i., p. 229.
1833. Purpura reticulata, Quoy and Gaimard. Astrolabe, Zool., vol. ii, p. 566, pl. 38, f. 17, 18.
1865. Purpura humilis, Crosse and Fischer. Jour. d. Conch., p. 51, pl. 2, f. 2.
1867. Purpura (Stramonita) neglecta, Angas. P.Z.S. Lond., p. 110, pl. 13, f. 3.
1880. Ricinula, reticulata Tryon. Man. Conch., vol. ii., pl. 59, f. 264.

Hab.—Western Port (common), Port Phillip, Jan Juc and Polwarth coast (Airey's Inlet, Lorne, etc.).

Obs.—It appears from the above as if Blainville had had access to the Astrolabe descriptions before the publication of that work, as we are not aware of any preliminary descriptions of the Astrolabe material, it would seem as if this species should properly be referred to as Blainville's. Perhaps some of our European friends may be able to solve this little difficulty.

Sistrum asperum, Lamarck.

Ricinula aspera, Lam. Enc. Méth., pl. 395, f. 4.
Ricinula asperus, Lam. 2nd ed., vol. x., p. 51.
1832. Ricinula biconica, Blainville. Nouv. Ann. du Mus., vol. i., p. 203, pl. 9, f. 1.
1846. Ricinula aspera, Reeve. Conch. Icon., vol. iii., pl. 2, f. 13.
1880. Ricinula asperus, Tryon. Man. Conch., p. 185, pl. 57, f. 216.

Hab.—Lakes Entrance, Gippsland, collected by Mr. Kershaw.

Obs.—Our shell agrees well with the figure and description of Blainville, and also with Reeve's figure, but the description of the latter is so poor that scarcely anything can be made out of it. Tryon makes R. morus, Lamarck, a synonym of this species, but with this we cannot agree. With regard to Tryon's figures we can accept figure 216, but figure 215 appears to be a distinct form.

Family CORALLIOPHILIDÆ.

Genus **Coralliophila**, H. and A. Adams, 1853.

Coralliophila wilsoni, Pritchard and Gatliff.

1897. Coralliophila wilsoni, Pritchard and Gatliff. P.R.S. Vic., n.s., vol. 10, pt. ii., p. 140.

Hab.—Port Phillip Heads, dredged alive by the late Mr. J. Bracebridge Wilson.

Obs.—This appears to be undoubtedly a new species, a description of which will be seen in the preceding paper.

Coralliophila, sp.

Hab.—Port Fairy and San Remo.

Obs.—Our shell seems to be somewhat closely allied to Coralliophila fritschi, Martens, Jahr. Mal. Gesell., i, p. 135, pl. 6, f. 3, from South Africa, which Tryon figures on pl. 65, f. 352. The material at present at our disposal we regret to say does not enable us to fix this species satisfactorily. Tryon figures C. costularis, Lam. (pl. 65, f. 365, 366), but he appears to represent two distinct species, neither of which at all represents our shell.

CORALLIOPHILA, sp.

Hab.—San Remo and Lorne.

Obs.—It was thought that this shell might be Rapana (Latiaxis) nodosa, A. Adams and Angas, but we feel certain that it cannot be that species. Shells sent to us from Port Jackson, under the name of Rapana nodosa, differ from ours in many respects, and it is even doubtful whether the Sydney shell has been correctly named. If Tryon be consulted on the matter, he does not clear up anything, but appears to be in a hopeless muddle himself. It seems probable that our shell is a new species, but want of sufficiently well-preserved specimens has debarred us from describing it at present.

Family LOTORIIDÆ.

Genus **Lotorium**, Montfort, 1810.

LOTORIUM AUSTRALIS, Lamarck.

1839. Triton australe, Lamarck. Anim. S. Vert. (Desh. & Edw. ed.), vol. iii., p. 722.

1843. Triton australe, Lamarck. Anim. S. Vert. (Desh. ed.), vol. ix., p. 625, No. 3.

Triton australis, Kiener. Coq. Viv., Triton, p. 32, No. 24, pl. 3, f. 1.

1844. Triton australis, Reeve. Conch. Icon., Triton, No. 12, pl. 4, f. 12a, and pl. 5, f. 12b.

1855. Triton australis, Sowerby. Genera of Shells, Triton, pl. 1.

1878. Triton australis, Kobelt. Conch. Cab. (ed. Kuster), vol. iii., Triton, p. 174, No. 15, pl. 50.

1880. Tritonium australis, Hutton. N.Z. Moll., p. 63.

1881. Triton australis, Tryon. Man. Conch., vol. iii., pl. 4, f. 23.

Hab.—Portland.

Obs.—Professor Tate and Mr. Adcock apparently regard Triton nodiferus, Lamarck, or T. nodifer, Lamarck, as the same shell as the above species as evidenced by the list of Aquatic Mollusca of South Australia, and they also include T. sauliæ, Reeve, in the synonymy. In our opinion it is doubtful that T. nodifer, Lam., and T. sauliæ, Reeve, are identical, and we cannot concede that T. australis is also identical and therefore refer to it as above.

LOTORIUM SUBDISTORTUM, Lamarck.

1822. Triton subdistortum, Lamarck. Anim. S. Vert., vol. vii., p. 186, and 1843 (ed. Desh.), vol. ix., p. 638, No. 23.
Triton subdistortum, Kiener. Coq. Viv., p. 37, No. 29, pl. 16, f. 2.
1844. Triton subdistortum, Reeve. Conch. Icon., vol ii., pl. 1, f. 2a, b.
1878. Triton subdistortum, Kobelt. Conch. Cab. (ed. Kuster), Triton, pp. 216, 267, pl. 70, f. 5, 6 (not pl. 61, f. 1-2).
1881. Triton subdistortus, Tryon. Man. Conch., vol. iii., p. 11, pl. 3, f. 18.
1886. Triton subdistortus, Watson. Chall. Zool., vol. xv., p. 390, No. 2.

Hab.—Off East Moncoeur Island, Bass Straits (Challenger); Airey's Inlet; Flinders, Western Port; Lakes Entrance, Gippsland.

LOTORIUM BASSI, Angas.

1869. Triton bassi, Angas. P.Z.S. Lond., p. 45, pl. 2, f. 2.
1878. Triton bassi, Kobelt. Conch. Cab. (ed. Kuster), vol. iii., p. 249, No. 97, pl. 68, f. 2, 3.
1881. Triton bassi, Tryon. Man. Conch., vol. 3, p. 11, pl. 3, f. 20.

Hab.—Corner Inlet, Bass Straits (J. Brazier), Flinders, Western Port.

LOTORIUM SPENGLERI, Chemnitz.

Murex cutaceus, Chemnitz (non Linné). Conch. Cab., vol. x., p. 266, pl. 163, f. 1559, 1560.
1795. Murex spengleri, Chemnitz. Conch. Cab., vol. xi., p. 117, pl. 191, f. 1839, 1840.
1822. Triton spengleri, Lamarck. Anim. S. Vert., vol. vii., p. 181.
1833. Triton spengleri, Quoy and Gaimard. Astrolabe, Zool., vol. ii., p. 538, pl. 40, f. 1, 2.

1843. Triton spengleri, Lam. (ed. Desh.). Vol. ix., p. 627, sp. 6.

1844. Triton spengleri, Reeve. Conch. Icon., vol. ii., pl. 11, f. 36.

1857. Tritonium barthelemyi, Bernardi. Jour. d. Conch., vol. vi., p. 54, pl. 1, f. 1.

1864. Triton waterhousei, Adams and Angas. P.Z.S. Lond., p. 35 (without figure).

1873. Triton spengleri, Hutton. Cat. N.Z. Moll., p. 13, No. 32.

1878. Triton strangei, Adams and Angas. P.Z.S. Lond., pl. 50, f. 16.

1878. Triton spengleri, Kobelt. Conch. Cab., (ed. Kuster). Vol. 3, p. 166, pl. 44, f. 5, 6, pl. 45, f. 5, 6.

1878. Triton barthelemyi, Kobelt. *Id.*, p. 222, No. 65, pl. 62, f. 1.

1878. Triton strangei, Kobelt. *Id.*, p. 269.

1878. Triton waterhousei, Kobelt. *Id.*, p. 257, No. 107, pl. 69, f. 1, 2.

1880. Tritonium spengleri, Hutton. N.Z. Moll., p. 64.

1881. Triton spengleri, Tryon. Man. Conch., vol. iii., p. 16, pl. 9, f. 61.

1881. Triton strangei, Tryon. Man. Conch., vol. iii., p. 17, pl. 9, f. 67.

1881. Triton barthelemyi, Tryon. Man. Conch., vol. iii., p. 17, pl. 10, f. 69.

1886. Triton spengleri, Watson. Chall. Zool., vol. xv., p. 393, No. 5.

Hab.—Port Phillip Bay, Western Port, Gippsland Coast, Barwon Heads, Polwarth Coast, Cape Otway, Warrnambool, etc.

Obs.—This shell is very common with us at almost every point of our coast, and as a consequence large series of specimens can be obtained with very little difficulty. When a series is studied the great amount of variation to which the species is subject can be readily seen, whereas when a small number of specimens are examined there appears to be several distinct species represented. We have, as may be seen above, lumped a number of species as identical with T. spengleri, because we have been unable to find constant characters to distinguish them, and have been able to bridge over all the gaps between the extremes of variation by serial specimens. Thus the main features of difference between T. waterhousei and T. spengleri, drawn attention to in the original description of the former by Messrs. Adams and Angas are that T. waterhousei has a squamato-pilose epidermis, a broad flattened varix to the outer lip, double liræ on the whorls, and a smooth inner lip anteriorly. Although specimens of this type can be obtained, still with the intermediate forms, we have been compelled to regard them as the same species. T. barthelemyi, Bernardi, appears to us to be but one of the senile types of T. spengleri, and we have no hesitation whatever in including it as a synonym. T. strangei, Adams and Angas, is also a synonym, having been founded upon a young specimen with a perfect and characteristic embryo; this portion of the larger and more adult specimens being almost always different in appearance on account of erosion or corrosion.

LOTORIUM EXARATUM, Reeve.

1844. Triton exaratus, Reeve. P.Z.S. Lond., p. 116.
1844. Triton exaratus, Reeve. Conch. Icon., pl. 13, f. 50.
1878. Triton exaratus, Kobelt. Conch. Cab., p. 231, pl. 64, f. 6, 7.
1881. Triton exaratus, Tryon. Man. Conch., vol. iii., p. 22, pl. 12, f. 102-104.

Hab.—Port Fairy (Rev. T. Whan), San Remo.

LOTORIUM EBURNEUM, Reeve.

1844. Triton eburneus, Reeve. P.Z.S. Lond., p. 118.
1844. Triton eburneus, Reeve. Conch. Icon., pl. 17, f. 69.
1878. Triton eburneus, Kobelt. Conch. Cab., p. 221, pl. 61, f. 9.
1881. Triton eburneus, Tryon. Man. Conch., vol. iii., p. 24, pl. 13, f. 115.

Hab.—Port Phillip, Western Port, Barwon Heads, Puebla Coast, Airey's Inlet, Lorne, etc.

Obs.—The habitat of this species is given by Reeve on the authority of Cuming as Island of Ticao, Phillipines; at the same time, however, he mentions that the shell has somewhat the form of the New Holland species T. Quoyi. With the latter remark we are very much inclined to agree, and though at present we refer to it above as a distinct species, we think it not unlikely that the discovery of further forms may considerably tone down the differences, if not entirely bridge over the gaps.

LOTORIUM VERRUCOSUM, Reeve.

1844. Triton verrucosus, Reeve. P.Z.S. Lond., p. 118.
1844. Triton quoyi, Reeve. *Id.*, p. 118.
1844. Triton verrucosus, Reeve. Conch. Icon., vol. ii., pl. 17, f. 71.
1844. Triton quoyi, Reeve. *Id.*, pl. 19, f. 93.
1878. Triton quoyi, Kobelt. Conch. Cab., p. 188, pl. 52, f. 6, 7.
1878. Triton verrucosus, Kobelt. *Id.*, vol. iii., p. 232, pl. 64, f. 9.
1881. Triton quoyi, Tryon. Man. Conch., vol. iii., p. 24, pl. 13, f. 116.
1881. Triton verrucosus Tryon. *Id.*, f. 117.

Hab.—Very common all along the Victorian Coast.

Obs.—This shell is one of the commonest along our shores, and as is generally the case with large numbers of representatives the variations apart from abnormal developments become perplexing. We cannot see any good reasons for considering T. quoyi and T. verrucosus as distinct species, even Reeve himself states that "care must be taken not to confound this shell (*i.e.*, T. verrucosus), with the lesser New Holland species, Triton quoyi." As both these species were described at the same time priority can only be given to that name which appears first. The more carefully this species is examined the more one is compelled to accept the above as the most convenient and useful conclusion, especially in view of the variation allowances that we have had to make in the case of other species of this genus.

Genus **Colubraria**, Schumacher, 1817.

COLUBRARIA BEDNALLI, Brazier.

1875. Triton (Epidromus) bednalli, Brazier. P.L.S., N.S.W., p. 6.
1875. Pisania tasmanica, T. Woods. P.R.S. Tas., p. 134.

1881. Triton (Epidromus) bednalli, Tryon. Man. Conch., vol. iii., pp. 32 and 225, pl. 85, f. 576.

Hab.—Port Phillip, Corio Bay, Western Port, Puebla coast.

Sub-genus **Argobuccinum**, Klein, 1753.

LOTORIUM (ARGOBUCCINUM) ARGUS, Gmelin.

Murex argus, Gmelin. Syst. Nat., p. 3547, No. 78, and Chemnitz, Conch. Cab., vol. iv., p. 75, pl. 127, f. 1223.

1822. Ranella argus, Lamarck. Anim. S. Vert., vol. vii., p. 151.

1832. Triton ranelliformis King. Zool. Jour., vol. v., p. 347.

1839. Ranella argus, Lamarck, (Desh. and Edward's 3rd ed.). Vol. iii., p. 694.

1843. Ranella argus, Lamarck (ed. Desh.). Vol. ix., p. 543, sp. 4, and Ranella vexillum, p. 553, sp. 20.

Ranella argus, Deshayes. Encycl. meth., vol. iii., p. 878, sp. 3, pl. 414, f. 3.

Ranella argus, Kiener. Icon. Coq. Viv., p. 31, sp. 23, pl. 8, f. 1.

Ranella vexillum, Sowerby. Conch. Illus., Ranella, pl. 1, f. 3.

Ranella kingii, d'Orbigny. Amér. mérid., vol. 5, p. 451.

1844. Ranella argus, Reeve. Conch. Icon., vol. ii., pl. 3, f. 12, and Ranella vexillum, f. 13.

Bursa (Apollon) proditor, v. Frauenfeldt. Novara, Moll., p. 4, pl. 1, f. 1.

1873. Ranella vexillum, Hutton. Cat. N.Z. Moll., p. 13,

1876. Ranella (Apollon) argus, Kobelt. Jahrb. deutsch malak. Gesell., p. 326, sp. 1, and Ranella (Appolon) proditor, sp. 3, and R. vexillum, sp. 4.

1878. Ranella argus, Kobelt. Conch. Cab. (ed. Kuster), p. 125, sp. 2, pl. 37, f. 5, 6, and Ranella vexillum, p. 126, sp. 3, pl. 38a, f. 1-3.

1880. Ranella vexillum, Hutton. N.Z. Moll., p. 65.

1881. Ranella (Argobuccinum) argus, Tryon. Man. Conch., vol. iii., p. 44, pl. 24, f. 61-65.

1886. Ranella (Argobuccinum) argus, Watson. Chall., Zool., vol. xv., p. 400, No. 6.

Hab.—Port Fairy, Flinders, Western Port.

Obs.—Mr. G. F. Harris in his recent catalogue of the Tertiary Mollusca of Australasia published by the British Museum uses *Apollo*, Montfort, (em. Harris) instead of *Argobuccinum*, but as there seems to be some confusion about the matter we prefer to refer to our species as above for the present.

LOTORIUM (ARGOBUCCINUM) LEUCOSTOMA, Lamarck.

1822. Ranella leucostoma, Lamarck. Anim. S. Vert., vol. vii., p. 150.

1833. Triton leucostomum, Quoy and Gaimard. Astrolabe, Zool., vol. ii., p. 546, pl. 40, f. 3-5.

1839. Ranella leucostoma, Lamarck (Desh. and Edw., ed. 3), vol. iii., p. 693.

1843. Ranella leucostoma, Lamarck (Desh. ed.), vol. ix., p. 542, sp. 2.

Ranella leucostoma, Kiener. Icon. Coq. Viv., p. 29, sp. 21, pl. 9, f. 1.

1844. Ranella leucostoma, Reeve. Conch. Icon., vol. ii., pl. 1, f. 4.

1873. Ranella leucostoma, Hutton. Cat. N.Z. Moll., p. 13.

1878. Ranella leucostoma, Kuster. Conch. Cab. (ed. Kuster), p. 127, sp. 2, pl. 37a, f. 4.

1880. Renella leucostoma, Hutton. N.Z. Moll., pp. 64, 202.

1881. Ranella (Argobuccinum) leucostoma, Tryon. Man. Conch., vol. iii., p. 42, pl. 23, f. 53, 54.

1886. Ranella (Argobuccinum) leucostoma, Watson. Chall. Zool., vol. xv., p. 401, No. 7.

Hab.—Portland; Lakes Entrance, Gippsland Coast.

Obs.—The Rev. R. Boog Watson states in the Challenger Report that he very much doubts the identification of the New Zealand shells with this species. About our specimens, however, there can be no doubt as they agree exactly with the figures and descriptions and with the Port Jackson examples of the species.

Family FASCIOLARIDÆ.

Genus **Fusus** (Klein, 1753), Lamarck, 1801.

FUSUS NOVÆHOLLANDIÆ, Reeve.

1847. Fusus novæhollandiæ, Reeve. Conch. Icon., vol. iv., p. 197, pl. 18, f. 70.
1880. Fusus novæhollandiæ, Sowerby. Thes. Conch., vol. iv., pts. xxxv. and xxxvi., p. 73, pl. 408, bis (Fusus, 4), f. 26.
Fusus novæhollandiæ, Kobelt. Conch. Cab. (ed. Kuster), p. 194, sp. 53, pl. 63, f. 1.
1881. Fusus spectrum, var. Tryon. Man. Conch., vol. iii., p. 58, pl. 33, f. 108, and pl. 37, f. 137.
1886. Fusus novæhollandiæ, Watson. Chall. Zool., vol. xv., p. 194, No. 7.

Hab.—Off East Moncoeur Island, Bass Strait, 38 to 40 fathoms, sand and shells (Challenger). Snake Island, Port Albert; Lakes Entrance, Gippsland.

FUSUS AUSTRALIS, Quoy and Gaimard.

1833. Fusus australis, Quoy and Gaimard. Astrolabe, vol. ii., p. 495, pl. 34, f. 9-14.
1847. Fusus crebriliratus, Reeve. Conch. Icon., vol. iv., sp. 20.
1847. Fusus aureus, Reeve. Conch. Icon., vol. iv.
1880. Fusus crebriliratus, Sowerby. Thes. Conch., vol. iv., p. 77, pl. 410 (Fusus 6), f. 49, 50.
1880. Fusus crebriliratus, Sowerby. *Id.*, pl. 410, f. 51.
Fusus crebriliratus, Kobelt. Conch. Cab., vol. iii., p. 177; Fusus, No. 35, pl. 55, f. 3.
1881. Fusus australis, Tryon. Man. Conch., vol. iii., p. 55, pl. 34, f. 113, 116, 118.

Hab.—Gippsland Coast.

Obs.—In Mr. D. J. Adcocks list of the Aquatic Mollusca of South Australia, the following are given as synonyms of the above:—F. marmoratus, Philippi; F. rudicostatus, Sowerby; F. lævigatus, Sowerby, and F. nodocinctus, A. Adams (? Philippi), but we are entirely unable to accept this synonymy as correct, and must therefore leave them out of consideration.

FUSUS PYRULATUS, Reeve.

1847. Fusus pyrulatus, Reeve. Conch. Icon., vol. iv., pl. 13, f. 50a, b.

1848. Fusus ustulatus, Reeve. Conch. Icon., pl. 17, f. 66.

1875. Fusus legrandi, T. Woods. P.R.S. Tas., pp. 137, 138.

1880. Fusus ustulatus, Sowerby. Thes. Conch., vol. iv., p. 77, pl. 410 (Fusus 6), f. 48.

1880. Pyrula pyrulatus, Sowerby. *Id.*, pt. xxxvi., p. 99, pl. 411 (Fusus 7), f. 74.

1881. Fusus ustulatus, Tryon. Man. Conch., vol. iii., p. 66, pl. 39, f. 170.

1881. Fusus pyrulatus, Tryon. *Id.*, pl. 39, f. 171-2.

Fusus pyrulatus, Kobelt. Conch. Cab. (ed. Kuster), p. 145, pl. 46, f. 2, 3.

1886. Fusus pyrulatus, Watson. Chall. Zool., vol. xv., p. 192, No. 3.

1891. Siphonalia (Austrofusus) sulcata, Tate (non Lamarck). T.R.S., S.A., vol. xiv., pt. ii., p. 257.

1891. Siphonalia (Austrofusus) pyrulata, Tate. T.R.S., S.A., vol. xiv., pt. ii., p. 257.

1895. Fusus pyrulatus, Verco. T.R.S., S.A., vol. xix., pt. i., p. 104, pl. 3, f. 5 (Dentition).

Hab.—Off East Moncoeur Island, Bass Strait, 38 to 40 fathoms, sand and shells (Challenger); Port Phillip, Flinders, Western Port, Corio Bay, Outer Geelong Harbour, Port Fairy (Rev. W. T. Whan).

Obs.—Making the same variation allowances as have been found necessary in the case of many of our other species, we find that we cannot do otherwise than regard F. ustulatus, Reeve, as but a variation of F. pyrulatus, Reeve, and F. legrandi, T. Woods, must also be included in the synonymy.

FUSUS DUNKERI, Jonas.

1844. Fusus dunkeri, Jonas. Malak. Beitrag., p. 129; Abbild. Phil., etc., vol. ii., p. 191, pl. 4, f. 4.

1847. Fusus taylorianus, Reeve. Conch. Icon., sp. 85.

1865. Siphonalia fuscozonata, Angas. P.Z.S. Lond., p. 56, pl. 2, f. 7-8.
1880. Fusus taylorianus, Sowerby. Thes. Conch., vol. iv., p. 84, pl. 8, f. 89.
1881. Fusus dunkeri, Tryon. Man. Conch., vol. iii., p. 60, pl. 37, f. 142.
1881. Siphonalia fuscozonata, Tryon. Man. Conch., *Id.*, p. 134, pl. 55, f. 361.
1893. Peristernia fuscozonata, Adcock. Cat. Mar. Shells of S.A., Adelaide, p. 4.
1895. Fusus dunkeri, Verco. T.R.S., S.A., vol. xix., pt. i., p. 106, pl. 3, f. 6 (Dentition).

Hab.—Sandringham; Port Phillip Bay.

Genus **Fasciolaria**, Lamarck, 1801.

FASCIOLARIA CORONATA, Lamarck.

1822. Fasciolaria coronata, Lamarck. Anim. S. Vert., vol. vii., p. 120.
1839. Fasciolaria coronata, Lamarck. *Id.* (Desh. and Edw. ed. 3), p. 655.
1843. Fasciolaria coronata, Lamarck. *Id.* (Desh. ed.), vol. ix., p. 435, sp. 6.
Fasciolaria coronata, Kiener. Icon. Coq. Viv., p. 9, sp. 6, pl. 9, f. 1.
Fasciolaria fusiformis, Valenciennes, in Kiener. Coq. Viv., p. 13, pl. 4, f. 2.
Fasciolaria coronata, Reeve. Conch. Icon., vol. ix., pl. 6, f. 14.
Fasciolaria coronata, Kobelt. Conch. Cab. (ed. Kuster), p. 150, sp. 17, pl. 27, f. 1, 2.
1881. Fasciolaria coronata, Tryon. Man. Conch., vol. iii., p. 77, pl. 63, f. 34.
1881. Fasciolaria fusiformis, Tryon. Man. Conch., vol. iii., pl. 61, f. 18, also f. 19.
1882. Fasciolaria coronata, Sowerby. Thes. Conch., pt. xxxvii., p. 10, sp. 3, pl. 424 bis. (i. Gen.), f. 3.

1882. Fasciolaria fusiformis, Sowerby. *Id.*, p. 10, pl. 424, f. 4.

1886. Fasciolaria coronata, Watson. Chall. Zool., vol. xv., p. 241.

1895. Fasciolaria fusiformis, Verco. T.R.S., S.A., p. 106, also F. coronata, p. 107.

Hab.—Very common in all the rocky pools along the Victorian coast.

Obs.—There has been considerable confusion about this species and its fusiform varieties. We are however only able to recognise one species of this genus up to the present. In Sowerby's Thesaurus conchyliorum the shell figured on plate 427, figure 31, is stated to be a copy of Kiener's figure of the type in the French Museum. This shell we do not appear to have. On plate 424, figure 4, however, a shell is figured as F. fusiformis as identified by Reeve, and is in the British Museum. This form we can obtain, but it is rare and seems to be a dwarfed form of F. coronata, Lamarck. This shell is also figured in Tryon's Manual of Conchology on plate 61, figure 18. In addition Tryon figures a shell under the name of F. fusiformis, Val., on plate 61, figure 19, which is but a variation of F. coronata, Lamarck.

Genus **Latirus**, Montfort, 1810.

LATIRUS CLARKEI, T. Woods.

1875. Siphonalia clarkei, T. Woods. P.R.S. Tas., p. 138.

1875. Siphonalia turrita, T. Woods. *Id.*, pp. 138, 139.

1893. Peristernia clarkei, Adcock. Cat. Mar. Shells S.A., p. 4.

Hab.—Port Phillip Bay, Western Port.

Obs.—The characters of this shell do not seem to exactly warrant its location in the genus Peristernia. Pending further investigation it may perhaps be convenient to refer to it as above.

Family BUCCINIDÆ.

Genus **Siphonalia**, A. Adams, 1863.

SIPHONALIA DILATATA, Quoy and Gaimard.

1833. Fusus dilatatus, Quoy and Gaimard. Astrolabe, Zool., vol. ii., p. 498, pl. 34, f. 15, 16.

1847. Fusus dilatatus, Reeve. Conch. Icon., f. 49.
1847. Fusus pastinaca, Reeve. *Id.*, f. 50.
1863. Fusus tasmaniensis, Adams and Angas. P.Z.S. Lond., p. 421, pl. 37, f. 1.
1873. Fusus dilatatus, Hutton. Cat. N.Z. Moll., p. 8.
1880. Fusus tasmaniensis, Sowerby. Thes. Conch., p. 70, pl. 5, f. 43.
1880. Fusus pastinaca, Sowerby. Thes. Conch., vol. iv., p, 82, pl. 7, f. 75.
1880. Fusus dilatatus, Sowerby. *Id.*, pl. 7, f. 76.
1880. Neptunæa dilatata, Hutton. N.Z. Moll., p. 50.
1881. Siphonalia maxima, Tryon. Man. Conch., p. 135, pl. 54, f. 335.
1891. Siphonalia oligostira, Tate. T.R.S., S.A., vol. xiv., p. 258, pl. 11, f. 6.

Hab.—Port Phillip Bay, Western Port, Gippsland Coast, Port Albert, off Lakes Entrace, etc., Warrnambool and Port Fairy.

Obs.—In this case also considerable lumping is necessary, especially in view of what is now commonly accepted by many as simple variation in very common species. The very large form of this species S. maxima is not by any means common, but is usually obtained off Cape Schanck, or in the neighbourhood of the Ninety-Mile Beach, Gippsland, and at first sight it would certainly appear to be a good species, but many links seem to undoubtedly connect it with S. dilatata. F. pastinaca, Reeve, and F. tasmaniensis, Adams and Angas, are also forms inseparable from the above. Siphonalia oligostira, Tate, is a form which can be obtained at Warrnambool and Port Fairy, as well as in South Australia; and is but a relatively non costate, fusiform variety, and bears exactly the same relation to the ordinary type of S. dilatata, Quoy and Gaimard, as the fusiform variety of Fusus coronata, Lamarck, commonly referred to as F. fusiformis, does to its ordinary coronate type. As we have already admitted this variation in the case of the Fusus we cannot possibly neglect it in this instance. Fusus adustus, Philippi, may also be a synonym of this species.

Genus **Pisania**, Bivona, 1832.

PISANIA RETICULATA, A. Adams.

1854. Pisania reticulata, A. Adams. P.Z.S. Lond., p. 138.

1881. Pisania reticulata, Tryon. Man. Conch., vol. iii., p. 147, pl. 71, f. 201.

Hab.—Port Phillip Bay, Western Port, Airey's Inlet, Warrnambool.

Genus **Cantharus** (Bolten, 1798), Mörch, 1852.

CANTHARUS AUSTRALIS, Pease.

1872. Cantharus australis, Pease. Amer. Jour. Conch., vol. vii., p. 21.

1881. Cantharus australis, Tryon. Man. Conch., vol. iii., p. 160, pl. 73, f. 269.

Cantharus assimilis, Angas.

Hab.—Port Fairy (Rev. W. T. Whan).

Genus **Cominella**, Gray, 1847.

COMINELLA COSTATA, Quoy and Gaimard.

1833. Buccinum costatum, Quoy and Gaimard. Astrolabe, vol. ii , p. 417, pl. 30, f. 17-20.

1846. Buccinum eburneum, Reeve. Conch. Icon., pl. 12, f. 93.

1846. Buccinum costatum, Reeve. Conch. Icon., pl. 4, f. 20.

1864. Buccinum angasi, Crosse. Jour. d. Conch., p. 275, pl. 11, f. 5.

1881. Cominella costata, Tryon. Man. Conch., vol. iii., p. 205, pl. 81, f. 430 and 434.

Hab.—A very common shell in most of the rock-pools of our coast.

Obs.—It is a point worthy of further investigation whether this shell can really be accepted as a good species. It is very closely related to the extremely common and variable form, C. lineolata, Lamarck, so much so that many of the gaps seem to be almost bridged over, but as yet we have not succeeded in obtaining a complete series. Another point of interest about them is that they are very commonly associated together in the same rock-pool.

Cominella lineolata, Lamarck.

Buccinum lineolatum, Lamarck. Encycl. Méth., pl. 400, f. 8.
1833. Buccinum lineolatum, Quoy and Gaimard. Astrolabe, vol. ii., p. 419, pl. 30, f. 14-16.
1843. Buccinum lineolatum, Lamarck. Anim. S. Vert., (Desh. ed.) vol. x., p. 164, 186.
Buccinum alveolatum, Kiener. Coq. Viv., p. 32, pl. 10, f. 34.
1846. Buccinum lineolatum, Reeve. Conch. Icon., pl. 5, f. 36.
1846. Buccinum alveolatum, Reeve. *Id.*, pl. 5, f. 37.
1846. Buccinum pluriannulata, Reeve. *Id.*, pl. 5, f. 38.
1846. Buccinum obscurum, Reeve. *Id.*, pl. 9, f. 68.
1847. Buccinum lineare, Reeve. *Id.*, pl. 14, f. 116.
1847. Buccinum lacteum, Reeve. *Id.*, pl. 14, f. 117.
1864. Buccinum adelaidensis, Crosse. Jour. d. Conch., p. 276, pl. 11, f. 6.
1880. Cominella lactea, Hutton. Man. N.Z. Moll., p. 55.
1881. Cominella lineolata, Tryon. Man. Conch., vol. iii, p. 204, pl. 80, f. 416.
1881. Cominella alveolata, Tryon. *Id.*, pl. 80, f. 420.
1881. Cominella pluriannulata, Tryon. *Id.*, pl. 81, f. 427.
1881. Cominella lineare, Tryon. *Id.*, pl. 81, f. 428.
1881. Cominella lactea, Tryon. *Id.*, pl. 81, f. 429.

Hab.—One of our commonest shells in the rocky pools along the coast.

Obs.—As can be seen from the above the synonymy in the case of this species is very heavy, but it does not require a very close examination of its many forms to convince one of their specific identity. This is an extremely good species for the study of variation.

Cominella (Agnewia) tritoniformis, Blainville.

1832. Purpura tritoniformis, Blainville. Nouv. Ann. du Mus., vol. i., p. 221, pl. 10, f. 10.

Purpura tritoniformis, Kiener, Icon. Coq. Viv., p. 37, pl. 8, f. 18.
1856. Cominella typica, Dunker. P.Z.S. Lond., p. 357.
1867. Adamsia typica, Angas. P.Z.S. Lond., p. 192.
1877. Agnewia typica, T. Woods. P.R.S. Tas., p. 29.
1878. Adamsia typica, Kobelt. Jahrb. deutsch. malak. Gesellsch., p. 236, sp. 1.
1880. Urosalpinx tritoniformis, Tryon. Man. Conch., vol. ii., p. 156, pl. 39, f. 491.
1886. Cominella (Adamsia) typica, Watson. Chall. Zool., vol. xv., p. 214, No. 2.

Hab.—Western Port, Port Phillip, Puebla Coast, Apollo Bay.

Obs.—In view of the ordinary laws of priority it does not seem possible to accept Adamsia for this shell as that name was preoccupied by E. Forbes for an Actinian genus in May, 1840 in the Annals of Natural History, 2nd series, vol. v., p. 181. On this account the late Rev. J. E. T. Woods proposed Agnewia to take the place of Adamsia and it seems only just that this should stand. Adamsia tritoniformis, Blainville, of New South Wales is clearly the same as our Victorian shell commonly known as Adamsia typica, Dunker, determined by a careful comparison of actual specimens. Tryon apparently regards Adamsia adelaidæ, Adams and Angas, and Purpura neglecta, Angas, as trifling varieties of Dunker's species. This, however, cannot be accepted. His figure 488 on plate 39 may probably represent C. albolirata, a variety of Sistrum adelaidensis, and from an examination of specimens of Adamsia adelaidæ, Ad. and Ang., forwarded from Port River, South Australia by Dr. Verco, we have concluded that the latter is but a slight varietal form of Sistrum adelaidensis. Tryon's figure 496 clearly represents Purpura neglecta, Angas, or what is the same thing Sistrum reticulatum, Crosse, but this cannot by any stretch of the imagination be regarded as C. tritoniformis, Blainville.

Genus **Zemira**, H. and A. Adams, 1853.

ZEMIRA AUSTRALIS, Sowerby.

Eburna australis, Sowerby. Conch. Illust., pt. xx., No. 8, pl. 20, f. 5.
1858. Eburna (Zemira) australis, Adams. Genera, vol. i., p. 110.

1859. Pseudoliva australis, Sowerby. Thes. Conch., vol. iii., pt. xix., p. 73, sp. 2, pl. 216, f. 7, 8.

Eburna australis, Reeve. Conch. Icon., vol. v., pl. 1, f. 4.

1880. Eburna australis, Löbbecke and Kobelt. Jahr. Malak. Gesellsch, p. 335, No. 10, pl. 7, f. 5-8.

Eburna australis, Kobelt. Conch. Cab. (ed. Kuster), Eburna p. 6, sp. 10, pl. 71, f. 7-9.

1881. Eburna (Zemira) australis, Tryon. Man. Conch., vol. iii., p. 213, pl. 82, f. 474.

1886. Eburna (Zemira) australis, Watson. Chall. Zool., vol. xv., p. 222.

Hab.—Off East Moncoeur Island, Bass Strait, 38 fathoms sand and shells (Challenger). Dredged alive in Western Port by Mr. C Gabriel.

Genus **Phos**, Montfort, 1810.

PHOS SENTICOSUS, Linné.

Murex senticosus, Linné. Syst. Nat., ed. xii., p. 1220, No. 546.

Turbo senticosus, Chemnitz. Conch. Cab., vol. iv., p. 308, pl. 155, f. 1466, 1467.

Murex senticosus, Chemnitz. *Id.*, vol. xi., p. 132, pl. 143, f. 1864-1866.

1822. Cancellaria senticosa, Lamarck. Anim. S. Vert., vol. vii., p. 111.

Buccinum senticosum, Kiener. Icon. Coq. Viv., p. 26, sp. 27, pl. 9, f. 31.

1833. Buccinum senticosum, Quoy and Gaimard. Astrolabe, vol. ii., p. 453, pl. 31, f. 1-4.

1843. Cancellaria senticosa, Lamarck. Anim. S. Vert., (ed. Desh.), vol. ix., f. 406.

1850. Phos senticosus, A. Adams. P.Z.S., p. 153, sp. 1.

1859. Phos senticosus, Sowerby. Thes. Conch., vol. iii., pt. xix., p. 89, sp. 1, pl. 221, f. 8-11.

1875. Phos senticosus, Woodward. Man. Mollusca, p. 221, pl. 5, f. 18.

1878. Phos senticosus, E. A. Smith. P.Z.S. Lond., p. 811.

1886. Phos senticosus, Brazier. P.L.S., N.S.W., vol. i., p. 176. No. 27.

1886. Phos senticosus, Watson. Chall. Zool., vol xv., p. 218.

Hab.—Gippsland Coast.

Genus **Nassa**, Lamarck. 1799.

NASSA FASCIATA, Lam.

1822. Buccinum fasciatum, Lam. Anim. S. Vert., vol. vii., p. 271, No. 28.

1833. Buccinum fasciatum, Q. and G. Astrolabe, vol. ii., p. 445, pl. 32, f. 18-21.

1853. Nassa fasciata, Reeve. Conch. Icon., vol. viii., pl. 4, f. 40.

1882. Nassa (Hima) fasciata, Tryon. Man. Conch., vol. iv., p. 46, pl. 14, f. 237, 238.

Hab.—Rather common at most parts of our coast.

NASSA JACKSONIANA, Quoy and Gaimard.

1833. Buccinum jacksonianum, Q. and G. Astrolabe, vol. ii., p. 452, pl. 32, f. 28, 29.

1834. Buccinum jacksonianum, Kiener. Coq. Viv. Mon. Bucc., pl. 19, f. 73.

1864. Nassa munieriana, Crosse. Jour. d. Conch., vol. xii., p. 345, pl. 13, f. 6.

1875. Nassa tasmanica, Tension Woods. P.R.S. Tas., p. 150.

1882. Nassa (Alectrion) monile, Tryon (non Kiener). Man. Conch., vol. iv., p. 28, pl. 9, f. 63, 64.

Hab.—Port Phillip generally; Western Port; Warrnambool and S.W. coast generally.

Obs.—N. monile, Kiener, we have not got, its habitat being New Guinea, New Caledonia, and thereabouts; with regard to this species Tryon seems to be in a hopeless muddle, and his figures are only confusing. Crosse's species N. munieriana seems to be only a somewhat irregularly grown example of N. jacksoniana, Q. and G. Watson regards N. munieriana, Crosse, as a depauperated variety of N. pauperata, Lam., but with this opinion we cannot concur.

NASSA PAUPERATA, LAM.

1822. Buccinum pauperatum, Lam. Anim. S. Vert., vol. vii., p. 278.

Buccinum pauperatum, Lam. Anim. S. Vert., vol. x., p. 183, sp. 56.

Buccinum pauperatum, Kiener. Icon. Coq. Viv., p. 90, sp. 89, pl. 29, f. 118.

1851. Nassa pauperata, A. Adams. P.Z.S., p. 95, sp. 9.

1853. Nassa pauperata, Reeve. Conch. Icon., vol. viii., pl. 5, f. 27.

1853. Nassa lirella, Reeve. *Id.*, pl. 14, f. 95.

1865. Nassa (Niotha) pauperata, Angas. P.Z.S., p. 163, No. 40.

1867. Nassa (Niotha) pauperata, Angas. P.Z.S., p. 190, No. 24.

1882. Nassa (Niotha) pauperata, Tryon. Man. Conch., vol. iv., p. 52, pl. 16, f. 288, 289 (?).

1886. Nassa (Niotha) pauperata, Watson. Chall. Zool., vol. xv., p. 176.

Hab.—On the sand banks at low tide Port Phillip generally; Western Port; Gippsland Coast; Port Albert; off East Moncoeur Islands, 38 fathoms (Challenger); Warrnambool, Port Fairy.

Obs.—N. Burchardi, Dunker, may be only a variety of this species. Tryon's figures need some checking, f. 288 can be accepted, but f. 289 to 291 are very doubtful.

NASSA LABECULA, A. Adams.

1851. Nassa labecula, A. Ad. P.Z.S., p. 98.

1853. Nassa labecula, Reeve. Conch. Icon., vol viii., pl. 25, f. 166.

1882. Nassa (Arcularia) labecula, Tryon. Man. Conch., vol. iv., p. 26, pl. 8, f. 31.

Hab.—Port Phillip.

Obs.—Tryon says N. labecula, A. Adams = N. jonasi, Dunker; the latter species however we have been unable to recognise among our shells.

NASSA RUFOCINCTA, A. Adams.

1851. Nassa rufocincta, A. Adams. P.Z.S., p. 106.

1864. Nassa tringa, Sowerby. Jour. d. Conch., p. 272, pt. 10, f. 7.

1865. Nassa compacta, Angas. P.Z.S., p. 154.
1882. Nassa (Hima) tringa, Tryon. Man. Conch., vol. iv., p. 47, pl. 15, f. 251.
1882. Nassa (Hima) compacta, Tryon. *Id.*, f. 252.

Hab.—Common at all the Port Phillip collecting grounds; Western Port, Gippsland Coast, South West Coast.

NASSA GLANS, Lin.

1767. Buccinum glans, L. Syst. Nat. (12th edit.), p. 1200, No. 456.
Buccinum glans, Chemnitz. Conch. Cab., vol. iv., p. 60, pl. 125, f. 1196-1200.
1853. Nassa glans, Reeve. Conch. Icon., vol. viii., pl. 1, f. 5.
Nassa glans var. intermedia, Dunk. Voy. Novara, Moll., p. 5, pl. 1, f. 2.
1882. Nassa (Alectrion) glans, Tryon. Man. Conch., vol. iv., p. 27, pl. 8, f. 52.
1886. Nassa (Alectryon) glans, Watson. Chall. Zool., vol. xv., p. 179, No. 10.

Hab.—Portarlington.

Obs.—The form of this species occurring with us is not N. suturalis, Lam., but rather the N. glans var. intermedia, Dunker, hitherto it has been a very rare shell with us.

Genus **Voluta**, Linn. 1758.

VOLUTA UNDULATA, Lamarck.

1880. Voluta undulata, Lamarck. Ann. du Mus., vol. v., p. 157, pl. 12, f. 1.
1812. Voluta undulata, Lamarck. *Id.*, vol. xvii, p. 71, sp. 36.
1822. Voluta undulata, Lamarck. Anim. S. Vert., vol. vii., p. 345, No. 38.
Voluta undulata, Lamarck. *Id.* ed. Desh., vol. x., p. 401, sp 38.
1833. Voluta undulata, Quoy and Gaimard. Astrolabe, vol. ii., p. 623, pl. 44, f. 1, 2.
Voluta undulata, Kiener. Icon. Coq. Viv., p. 52, sp. 44, pl. 44, f. 1.

Voluta undulata, Kuster. Conch. Cab., p. 163, sp. 13, pl. 3, f. 3, 4.

1849. Voluta undulata, Reeve. Conch. Icon., vol. vi., pl. 11, f. 26.

1864. Voluta (Amoria) undulata, Angas. P.Z.S. Lond., p. 52, sp. 18.

Voluta undulata, Sowerby. Thes. Conch. pt. 5, p. 196, sp. 9, pl. 48, f. 28, 29.

Voluta angasi, Sowerby. *Id.*, pt. 23, p. 271, sp. 73, f. 99.

Voluta angasi, Cox. Distrib. Austr. Volutes, p. 12, sp. 14.

1869. Voluta sclateri, Cox. P.Z.S. Lond., p. 358, pl. 26, f. 3.

1871. Voluta australiæ, Cox. P.Z.S. Lond., p. 643, pl. 52, f. 1, 1a.

1871. Voluta (Amoria) undulata, Crosse. Jour. d. Conch., vol. xix., p. 288, sp. 36.

1877. Voluta (Amoria) undulata, Kobelt. Jahr. deutsch. Malak. Gesellsch., p. 307, sp. 36.

1882. Voluta (Amoria) undulata, Tryon. Man. Conch., vol. iv., p. 92, pl. 28, f. 97, 98.

1882. Voluta (Aulica) australiæ, Tryon. *Id.*, p. 91, pl. 26, f. 73.

1882. Voluta (Amoria) sclateri, Tryon. *Id.*, p. 92, pl. 27, f. 83.

1886. Voluta (Scaphella) undulata, Watson. Chall. Zool., vol. xv., p. 257, No. 7.

Hab.—Off East Moncoeur Island, Bass Strait (Challenger), off Lakes Entrance, Gippsland, Western Port, Sorrento, Corner Inlet.

Obs.—The only difference that we can discover in V. sclateri is that the longitudinal dark markings are absent or partially faintly indicated. In V. australiæ the usual longitudinal markings in some cases cross and also assume a zig-zag form, in other respects we cannot separate it from V. undulata. Brazier considers V. kingii, Cox, to be a variety, but judging from the figure of the type it may possibly be a distinct species, though the material in hand at present does not enable us to be positive.

VOLUTA ROADKNIGHTÆ, McCoy.

1881. Voluta roadknightæ, McCoy. A.M.N.H., 5 ser., vol. viii., p. 89, pl. 7, f. 1-2.

1882. Voluta (Alcithoe) roadknightæ, Tryon. Man. Conch., vol. iv., p. 96, pl. 30, f. 128.

1887. Voluta roadknightæ, Sowerby. Thes. Conch., pt. xliv., p. 298, pl. 513, f. 143.

Hab.—Gippsland Coast (Worcester), Portland (Nat. Mus.).

Obs.—The type of this species is in the National Museum, Melbourne, and is referred to as having been obtained at Portland. All the subsequently discovered specimens up to the present have been procured at different parts of the Gippsland Coast as far as Victoria is concerned. It has recently been discovered in Tasmania.

VOLUTA ZEBRA, Leach.

1814. Voluta zebra, Leach. Zool. Misc., vol. i., pl. 12, f. 1.

1814. Voluta lineata, Leach. *Ib.*, vol. i., pl. 12, f. 2.

(?) 1822. Marginella radiata, Lam. Anim. S. Vert., vol. x., p. 436.

1849. Voluta zebra, Reeve. Conch. Icon., vol. vi., pl. 18, f. 43.

1882. Voluta (Amoria) zebra, Tryon. Man. Conch., vol. iv., p. 93, pl. 28, f. 91.

Hab.—Gippsland Coast.

VOLUTA PAPILLOSA, Swainson.

Voluta papillosa, Swainson. Appx. Bligh. Cat.

Scaphella papillaris, Swainson. Malac., pt. i., p. 180, f. 12*a*, and pt. ii., p. 308.

Voluta papillosa, Sowerby. Thes. Conch., vol. i., p. 207, pl. 47, f. 30.

Voluta sowerbyi, Kiener. Icon. Coq. Viv., pl. 50.

1849. Voluta papillaris, Reeve. Conch. Icon., vol. vi., pl. 4, f. 10.

1855. Volutella papillosa, Gray. P.Z.S., p. 63.

1871. Voluta (Alcithoe) papillosa, Crosse. Jour. d. Conch., vol. xix., p. 297.

1879. Voluta macquariensis, Petterd. Jour. of Conch., vol. ii., p. 343.

1882. Voluta (Alcithoe) papillosa, Tryon. Man. Conch., vol. iv., p. 96, pl. 28, f. 106.

Hab.—Phillip Island, Western Port, Portland.

VOLUTA FUSIFORMIS, Swainson.

Voluta fusiformis, Swainson. Appx. Bligh. Cat.

Voluta fusiformis, Swainson. Malac., pt. i., p. 108, pt. ii., p. 318.

Voluta fusiformis, Sowerby. Thes. Conch., vol. i., p. 208, pl. 54, f. 100.

1849. Voluta fusiformis, Reeve. Conch. Icon., vol. vi., pl. 3, f. 6.

1855. Scapha fusiformis, Gray. P.Z.S., p. 58.

1864. Scapha fusiformis, Angas. P.Z.S., p. 50.

1871. Voluta (Alcithoe) fusiformis, Crosse. Jour. d. Conch., vol. xix., p. 296.

1882. Voluta (Alcithoe) fusiformis, Tryon. Man. Conch., vol. iv., p. 95, pl. 28, f. 103.

Hab.—Gippsland Coast, off Western Port and Cape Schanck.

VOLUTA MAMILLA, Gray.

1844. Cymba mamilla, Gray. P.Z.S. Lond., p. 149.

1855. Voluta mamilla, Gray, P.Z.S., p. 55.

Voluta mamilla, Sowerby. Thes. Conch., vol. i., p. 207, pl. 50, f. 57, 58.

1849. Voluta mamilla, Reeve. Conch. Icon., vol. vi., pl. 19, f. 44.

1859. Cymbium mamilla, Chenu. Man. de Conch., vol. i., p. 186, f. 942.

1871. Mamillana mamilla, Crosse. Jour. d. Conch., vol. xix., p. 308.

1872. Scapha mamilla, Brazier. P.Z.S, p. 23.

1882. Voluta (Mamillana) mamilla, Tryon. Man. Conch., vol. iv., p. 101, pl. 29, f. 122.

Hab.—Off Cape Schanck.

Genus **Lyria**, Gray. 1847.

LYRIA MITRÆFORMIS, Lamarck.

Voluta mitræformis, Lam. Anim. S. Vert., vol. x., p. 404.

Voluta multicostata, Brod. Zool. Journ., vol. iii., pl. 3, f. 2.

Voluta mitræformis, Sowerby. Thes. Conch., vol. i., pl. 53, f. 81, 82.

1849. Voluta mitræformis, Reeve. Conch. Icon., vol. vi., pl. 3, f. 7a, 7b.

1882. Lyria mitræformis, Tryon. Man. Conch., vol. iv., p. 103, pl. 31, f. 143.

Hab.—Gippsland Coast, Western Port, Warrnambool.

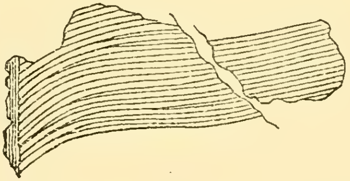
NOTE.—In the notes obtained from Professor R. Tate, Voluta magnifica, Lamarck, is included as a Victorian shell, but up to the present we have not obtained or seen any specimens of this species from our coast.

Art. XXIII.—*Note on an Additional Genus of Fossil Plants found in the Bacchus Marsh Sandstone by Geo. Sweet, Esq., F.G.S.*

By Sir Frederick McCoy, K.C.M.G., M.A., D.Sc., F.R.S., etc.

[Read 9th December, 1897.]

Among the many important discoveries made by Mr. George Sweet, throwing light on the geological age of various formations in Victoria, is a very interesting specimen obtained by him in March, 1897, from the Bacchus Marsh sandstone, in which the ferns of the genus *Gangamopteris* (McCoy) abound, with so few traces of any other forms that the present discovery is of special interest to geologists, bearing out the suggestions I have already published, as to the age of the beds, from the data previously known. It is a species of the large forms of the genus *Tæniopteris* found in mesozoic formations in so many parts of the world. I have much pleasure in dedicating it to the discoverer.



Tæniopteris sweeti, McCoy. (Nat. size).

Frond about three inches six lines wide; mid-rib convex above, finely and irregularly sulcated longitudinally, about one line wide. Secondary veins very slender, about twice their diameter apart; arching from the mid-rib at about 45 deg., quickly running nearly parallel to each other in a direction nearly at right angles to the outer edge of the frond on each side; chiefly simple, but some dichotomising once between the mid-rib and the margin, more rarely dichotomising twice; about nine veins in quarter of an inch at the above widths of the frond.

This species is of the type of Dr. Weiss's *T. multinervis*, remarkable for the extreme tenuity and closeness of the nerves or veins, but may be specifically distinguished by the above characters and measurements.

Rare in the Gangamopteris Sandstone of Bacchus Marsh.

The type specimen has been presented to the National Museum of Melbourne by the discoverer.

ANNUAL REPORT OF THE COUNCIL

FOR THE YEAR 1896.

The Council of the Royal Society herewith presents to the Members of the Society the Annual Report and Balance Sheet for the Year 1896.

The following Meetings were held, and Papers read during the Session:—

March 12.—1. "On the Occurrence of the Anchoring Tubes of Adeona in the older Tertiaries of Victoria, with an account of their Structure," by T. S. Hall, M.A. 2. "Description of Two New Species of Marsupials from Central Australia," by Professor Baldwin Spencer, M.A. 3. "An Exhibit of Photographs illustrating Dr. Röntgen's recent discovery," by Professor T. R. Lyle, M.A.

May 14.—1. "Description of a New Species of Terrestrial Isopoda allied to the genus Phreatoicus," by Professor Baldwin Spencer, and T. S. Hall, M.A. 2. "On the Representation of the Periodic Law, with special reference to Argon and Helium," by Professor Orme Masson, M.A. 3. "Geological Notes on the Geni and Indi Rivers and Monaro Gap, Mount Kosciusko, N.S.W.," by A. E. Kitson. 4. "An Exhibit of Vacuum Tubes containing Argon and Helium, showing their Spectra," by Professor Orme Masson, M.A. 5. "An Exhibit of Photographs taken by Röntgen's method, showing details of the structure of the skeletons of various animals," by Professor Lyle, M.A.

June 11.—1. "The Temperatures of Reptiles, Monotremes, and Marsupials," by Alexander Sutherland, M.A. 2. "Note on the Aboriginal Rock Painting at the Victoria Range, County of Dundas, Victoria," by Rev. John Mathew, M.A.

July 9.—1. "On Some Facts in the Geographical Distribution of Land and Freshwater Vertebrates in Victoria," by A. H. S. Lucas, M.A., B.Sc. 2. "The Burbung of New England Tribes, N.S.W.," by R. H. Mathews (communicated by Professor Baldwin Spencer, M.A.).

August 13.—1. "A new Species of Diplodactylus from Central Australia," by A. H. S. Lucas, M.A., B.Sc., and C. Frost, F.L.S. 2. "A Locality List of all the Minerals hitherto recorded from Victoria," by John A. Atkinson. 3. "Notes on Boiling Point Thermometers," by T. W. Fowler, M.C.E.

September 10.—1. "On the Occurrence of Graptolites in North-eastern Victoria," by T. S. Hall, M.A. 2. "The Relation between the Hebrew and British Systems of Weights and Measures," by C. F. Howard (communicated by E. F. J. Love, M.A.). 3. "A Contribution to the knowledge of the Tertiary Rocks in the Neighbourhood of Melbourne," by T. S. Hall, M.A. and G. B. Pritchard. 4. "Aboriginal Bora held at Tallwood, Queensland, in 1895," by R. H. Mathews (communicated by Professor Baldwin Spencer, M.A.).

October 22.—A Conversazione was held in the Society's Hall.

November 12.—1. "On the Spectra of the Alkalies," by L. Rummel (communicated by R. L. J. Ellery, F.R.S., etc.). 2. "Catalogue of the Non-calcareous Sponges collected by J. Bracebridge Wilson, Esq., M.A., in the neighbourhood of Port Phillip Heads," Part III., by Professor Arthur Dendy, D.Sc. 3. "The Variations in the Spinal Nerves of *Hyla aurea*," by Miss G. Sweet, B.Sc. (communicated by Professor Spencer, M.A.). 4. "Notes on the Popular Records of Leichardt's later Expeditions," by H. K. Rusden. 5. "Geological Notes on the Lower Indi River, Eastern Benambra," by A. E. Kitson and W. Thorn.

During the course of the year the Society has lost three Members by death, seven by resignation, and six Associates by resignation, while it has gained three new Members and six new Associates.

The Council has to record with deep regret the death of Baron von Mueller, who, though in recent years he has not taken any active part in the work of the Society, was one of its original Members, and for many years presided over its meetings.

During the year the following publication has been issued, viz., "Proceedings," Vol. VIII. (New Series), and at the present moment Vol. IX. is in the press and will be issued shortly.

The reduction of the Government Grant to £100 has very seriously crippled the work of the Society so far as publishing is concerned, and it is much to be hoped that with a return of more prosperous times the vote may be increased so as to enable the Society to publish the papers presented to it, which at present it is unable to do with anything like completeness.

With the object in view of bringing Members of the Society together at an annual gathering, the Council decided to re-inaugurate the Conversazione which was once an annual institution, and accordingly one was held in the Society's Hall, on the evening of Thursday, 22nd October, taking the place of the usual monthly meeting. Short Lecturettes were given by Professor Lyle and Dr. Barrett, and a Musical Programme was rendered by Students of the Conservatorium. It is intended in the future to continue, in some form or another, the Annual Social Re-union of Members of the Society.

The Librarian reports as follows:—I have much pleasure in reporting the steady growth of the Society's Library; 1316 books and parts of periodicals were received during the year 1896.

Owing to pressure on the space in the Library, about 200 feet of shelving were erected in the Council Room. This enabled the books to be subdivided; all works published in England, France, Germany, Austria and Holland remain in the Library; works coming from other countries, and therefore printed in the less widely known languages, are now housed in the Council Room, where a separate catalogue of them is kept. Very little binding has been done, owing to lack of funds; this is a great misfortune, as many of the unbound volumes are breaking up, and there is a serious risk of loss of odd leaves, plates, etc.—a risk which now applies to some thousands of volumes, and involves a probable serious depreciation in value of the Society's property.

The Honorary Treasurer in Account with the Royal Society of Victoria.

Dr.			Cr.	
To Balance from 29th February, 1896		£38 3 5	By Printing and Stationery	£149 19 0
Government Grant—			Rates	3 10 0
Balance of Vote, 1895-96		£100 0 0	Gas and Fuel	8 6 1
Instalment for 1895-96		50 0 0	Salary of Assistant-Secretary	100 0 0
Entrance Fees		2 2 0	Custodian	6 0 0
Subscriptions—			Collector's Commission	16 14 8
Members	£64 1 0		Insurance	4 0 0
Country Members	6 7 0		Postages	14 4 9
Associates	35 3 6		Repairs	20 18 10
Arrears	62 19 0		Books and Periodicals	6 10 6
		168 10 6	Freight	6 11 7
Rent of Rooms		16 5 0	Conversazione	21 2 6
Interest		9 0 0	Binding	3 18 0
			Incidentals	5 14 0
			Balance (28th February, 1897)	16 11 0
		£384 0 11		£384 0 11

PUBLISHING AND RESEARCH FUND.

Dr.				Cr.			
To Fixed Deposit in Bank	£300	0	0	By Fixed Deposit in Bank of Australasia ...	£300	0	0
Interest on same	9	0	0	Interest transferred to General Account	9	0	0
	£309	0	0		£309	0	0

Compared with the Vouchers, Bank Pass-Book and Cash-Book, and found correct,

C. R. BLACKETT,
Hon. Treasurer.

H. MOORS,
JAMES E. GILBERT, } *Auditors.*

28*th February*, 1897.

The Royal Society of Victoria.

LIST OF MEMBERS,

WITH THEIR YEAR OF JOINING.

Patron.

His Excellency Lord Brassey, K.C.B.	1895

Honorary Members.

Agnew, The Hon. Sir J. W., K.C.M.G., M.E.C., M.D., Hobart, Tasmania	1888
Clarke, Lieut.-Gen. Sir Andrew, K.C.M.G., C.B., C.I.E., London (*President*, 1855 *to* 1857)	1854
Forrest, The Hon. Sir J., K.C.M.G., West Australia ...	1888
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Liversidge, Professor A., F.R.S., LL.D., University, Sydney, N.S.W.	1892
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Verbeek, Dr. R. D. M., Buitenzorg, Batavia, Java ...	1886

LIFE MEMBERS.

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Bosisto, Joseph, The Laboratory, Bridge-road, Richmond	1857
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Rusden, H. K., Ockley, Bay and St. Kilda streets, Brighton	1866
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McCoy, Professor Sir F., K.C.M.G., D.Sc., F.R.S. (*President*, 1864), University, Melbourne	1855
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Oldfield, Lenthal, 36 Nicholson-street, Fitzroy, Victoria	1890
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Cameron, John, Orbost, Victoria	1888
Clark, Donald, B.C.E., School of Mines, Bairnsdale, Victoria	1892
Conroy, Jas. McDowall, Wingham, Manning River, N.S.W.	1877
Crerar, T. G., Stawell, Victoria	1897
Dawson, J., Scott-street, Camperdown, Victoria	1891
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Martell, F. J., School of Mines, Ballarat	1897
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Murray, Stuart, C.E., Department of Mines, Melb.	1874
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Officer, Sidney, Maryvale, Boroke	1890
Powell, Walter D. T., Cape Moreton Light House, Brisbane, Queensland	1886
Purdie, A., M.A., School of Mines, Bendigo, Victoria	1892
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ASSOCIATES.

Avery, D., M.Sc., Mount Egerton, Victoria	1893
Baker, Thomas, Bond-street, Abbotsford, Victoria	1889
Bale, W. M., F.R.M.S., Walpole-street, Hyde Park, Kew, Victoria	1887
Barnard, Robert J. A., M.A., Queen's College, Carlton	1892
Bennetts, W. R., 184 Brunswick-street, Fitzroy, Victoria	1894
Booth, John, M.C.E., Rennie-street, Coburg, Victoria	1872

Campbell, A. J., Elm Grove, Armadale, Victoria	1894
Cresswell, Rev A. W. M.A., St. John's Parsonage, Camberwell, Victoria	1887
Danks, A. T., 391 Bourke-street west, Melbourne	1883
Ferguson, W. H., 23 Service Crescent, Albert Park	1894
Finney, W. H., Bridport-street, South Melbourne	1881
Fison, Rev. Lorimer, M.A., Essendon, Victoria	1889
Gabriel, J., Victoria-street, Abbotsford, Victoria	1887
Green, W. Heber, Albany Crescent, Surrey Hills, Victoria	1896
Hart, T. S., M.A., School of Mines, Ballarat	1894
Herman, Hyman, Department of Mines, Melbourne	1897
Hill, W. H. F., Glenrowan, Dandenong-road, Windsor	1894
Holmes, W. A., Telegraph Engineer's Office, Railway Department, Melbourne	1879
Hubbard, J. R., Perth, West Australia	1884
Ingamells, F. N., Observatory, Melbourne	1889
Jutson, J. T., 32 Bastings-street, Northcote, Victoria	1895
Kernot, Frederick A., 66 Russell-street, Melbourne	1881
Kitson, A. E., 372 Albert-street, East Melbourne	1894
Lambert, Thomas, Bank of New South Wales, Collins-street, Melbourne	1890
Le Souëf, Dudley, Zoological Gardens, Royal Park	1894
Lidgey, E. A., Department of Mines, Melbourne	1894
Luly, W. H., Department of Lands, Treasury, Melbourne	1896
Maclean, C. W., 276 Walsh-street, South Yarra	1879
Melville, A. G., Mullen's Library, Collins-street east, Melbourne	1889
Phillips, A. E., c/o A. C. Walker, Bank Place, Collins-street, Melbourne.	1883
Pritchard, G. B., Mantell-street, Moonee Ponds, Victoria	1892
Robertson, E. J., 411 Toorak-road, South Yarra, Victoria	1895
Robinson, C. A., Lands Department, Treasury, Melbourne	1894
Rosenhain, Walter, B.A., Williams-street, South Yarra	1896
Schäfer, R., Union-street, Windsor, Victoria	1883
Shaw, Alfred C., Bond-street, Abbotsford, Victoria	1896

Shephard, John, 135 City-road, South Melbourne ...	1894
Smith, B. D., 373 Collins-street, Melbourne	1897
Stewart, C., Oxford Chambers, Bourke-street, Melb....	1883
Strettle, W. S., B.C.E., Public Works Department, Perth, W.A.	1891

Wallace, W., Mines Department, Treasury, Melbourne ...	1896
Wedeles, James, 231 Flinders-lane, Melbourne ...	1896

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Biological Society of Liverpool	Liverpool
Bodleian Library	Oxford
British Museum	London
British Museum (Natural History)	London
Colonial Office Library	London
Foreign Office Library	London
Free Public Library	Liverpool
Geological Society	London
Institute of Mining and Mechanical Engineers	Newcastle
Institution of Civil Engineers	London
Linnæan Society	London
Literary and Philosophical Society	Liverpool
Literary and Philosophical Society	Manchester
Manchester Museum, Owens College	Manchester
Marine Biological Laboratory	Plymouth
Naturalists' Society	Bristol
"Nature"	London
"Natural Science"	London
Owens College Library	Manchester
Patent Office, 25 Southampton Buildings	London
Philosophical Society	Cambridge
Physical Society	London
Radcliffe Library	Oxford
Royal Astronomical Society	London
Royal College of Science	South Kensington
Royal Colonial Institute	London
Royal Gardens	Kew
Royal Geographical Society	London
Royal Microscopical Society	London
Royal Society	London
Statistical Society	London
University College	London
University Library	Cambridge
Yorkshire College	Leeds

Scotland.

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Geological Society	Edinburgh
Royal College of Physicians' Laboratory	Edinburgh
Royal Observatory	Edinburgh
Royal Physical Society	Edinburgh
Royal Society	Edinburgh
Royal Scottish Society of Arts	Edinburgh
Scottish Geographical Society	Edinburgh
University Library	Edinburgh
University Library	Glasgow
Philosophical Society	Glasgow

Ireland.

Natural History and Philosophical Society	Belfast
Royal Dublin Society	Dublin
Royal Irish Academy	Dublin
Trinity College Library	Dublin

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Academie der Wissenschaften	Munich
Gesellschaft für Erdkunde	Berlin
Grossh. Hessische Geologische Anstalt	Darmstadt
Jenaische Zeitsch. f. Medicin und Naturwissenschaft	Jena
Königl. Botanische Gesellschaft	Regensburg
Königl. Offentl. Bibliothek	Dresden
Königl. Preussische Akademie der Wissenschaften	Berlin
Königl. Sächs. Gesellschaft der Wissenschaften	Leipzig
Königl. Societät der Wissenschaften	Göttingen
Naturforschende Gesellschaft	Emden
Naturforschende Gesellschaft	Halle
Naturforschende Gesellschaft	Leipzig
Naturforschende Gesellschaft Bleichstrasse 59.	Frankfurt am M.
Naturhistorisch Medicinischen Verein	Heidelberg
Naturhistorisches Museum	Hamburg
Naturhistorisches Museum	Hanover
Naturwissenschaftlicher Verein	Bremen
Oberhessische Gesellschaft für Natur u. Heilkunde	Giessen
Schlesische Gesellschaft für vaterländische Cultur	Breslau
Verein für Erdkunde	Darmstadt
Verein für Erdkunde	Halle
Verein für Naturkunde	Kassel

AUSTRO-HUNGARY.

K. K. Sternwarte	Prague
K. Akademie der Wissenschaften	Vienna
K. K. Geologische Reichsanstalt	Vienna
K. K. Geographische Gesellschaft	Vienna
K. K. Naturhistorisches Hofmuseum	Vienna
K. K. Zoologische Botanische Gesellschaft	Vienna

SWITZERLAND.

Geographische Gesellschaft	Berne
Geogr. Commerc. Gesellschaft	St. Gallen
Geogr. Commerc. Gesellschaft	Aarau
Naturforschende Gesellschaft	Zürich
Schweizerische Naturforschende Gesellschaft	Berne
Société de Physique et d'Histoire Naturelle	Genéve

FRANCE.

Académie des Sciences, Belles Lettres et Arts	Lyon
Bibliothéque et Faculté des Sciences	Marseilles
Feuilles des Jeunes Naturalistes	Paris
Observatoire Météorologique	Paris
Société de Geographie	Paris
Société d'Etudes Scientifiques	Paris
Société Nationale de Cherbourg	Cherbourg
Société Zoologique de France	Paris
Société des Sciences Naturelles de l'Ouest de la France (Museum)	Nantes

ITALY.

Biblioteca Nazionale Centrale Vittorio Emanuele	Rome
British and American Archæological Society	Rome
Museo di Zoologia ed Anatomia Comp., R. Università	Turin
Ministerio dei Lavori Pubblici	Rome
R. Accademia delle Scienze dell' Instituto	Bologna
Reale Accademia di Scienze	Palermo
Reale Accademia di Scienze, Lettere ed Arti	Lucca
Regia Accademia di Scienze, Lettere ed Arti	Modena
Società Geografica Italiana	Rome
Società Toscana di Scienze Naturali	Pisa
Zoological Station	Naples

SPAIN AND PORTUGAL.

Real Academía de Ciencias exactas, físicas y naturaes	Madrid
Sociedade de Geographia	Lisbon

HOLLAND AND BELGIUM.

Académie Royale de Belgique	Bruxelles
Musée Teyler	Haarlem
Natuurkundig Genootschap	Groningen
Nederlandische Botan. Vereeniging	Nijmegen
Kon. Akademie van Wetenschappen	Amsterdam
Société Hollandaise des Sciences	Haarlem
Société Malacologique Royale de Belgique	Bruxelles
Société Provinciale des Arts et Sciences	Utrecht

DENMARK, SWEDEN, NORWAY.

Académie Royale	Copenhagen
Entomologiska Föreningen	Stockholm
Videnskabs-Selskabet	Christiania
Royal University Library	Upsala
Kongl. Vetenskaps Akademien	Stockholm
Royal Academy of Belles-Lettres, History, and Antiquities	Stockholm

RUSSIA AND ROUMANIA.

Institut Météorologique de Roumanie	Bucharest
Jardin Botanique Imperial	St. Petersburg
Minister of Agriculture, St. Petersburg, c/o Russian Consulate	Melbourne
Russian Geographical Society, Priamom Branch, Ishita	Siberia
Société des Naturalistes de l'Université de Kasan	Kasan
Société des Naturalistes Kiew	Kiew
Société des Naturalistes de la Nouvelle Russie	Odessa
Société Impériale des Naturalistes	Moscow
Société Impériale Russe de Geographie	St. Petersburg
Magyar Kiralyi Természettudomanyi Tarsulat	Budapest

CAPE OF GOOD HOPE.

South African Museum	Cape Town
South African Philosophical Society, Observatory	Cape Town

INDIA.

Geological Survey of India	Calcutta
G. V. Juggarow Observatory	Vizagapatam
Madras Literary Society	Madras
Natural History Society	Bombay
Royal Bengal Asiatic Society	Calcutta
Royal Asiatic Society, Ceylon Branch	Colombo

JAVA.

Bataviaasche Genootschap van Kunsten en Wetenschappen	Batavia
Magnetical and Meteorological Observatory	Batavia

MAURITIUS.

Royal Alfred Observatory	Mauritius

CHINA AND JAPAN.

Astronomical Observatory	Hong Kong
China Branch of the Royal Asiatic Society	Shanghai
Imperial University	Tokio

CANADA.

Canadian Institute	Toronto
Geological and Natural History Survey of Canada	Ottawa
Minister's Office (Militia and Defence)	Ottawa
Royal Society of Canada	Montreal

UNITED STATES.

Academy of Natural Sciences	Davenport
Academy of Natural Sciences	Philadelphia
Academy of Sciences	Iowa
American Museum of Natural History, Central Park	New York
American Academy of Arts and Sciences	Boston
American Geographical Society	New York
American Philosophical Society	Philadelphia
Bureau of Ethnology, Smithsonian Institute	Washington
California Academy of Sciences	San Francisco
Colorado Scientific Society	Denver
Cooper Union for the Advancement of Science & Art	New York
Denison University	Ohio
Department of Agriculture	Washington, D.C.
Geological Survey	Iowa
Johns Hopkins University	Baltimore
Maryland Historical Society	Baltimore
National Academy of Sciences	Washington
New York Public Library	New York
Office of Chief of Engineers, U.S. Army	Washington
Philosophical Society	Washington
"Science"	New York
Smithsonian Institution	Washington
Society of Natural History	Boston
Society of Natural Sciences	Buffalo

Texas Academy of Sciences	Austin
United States Geological Survey	Washington
University of California	Berkeley, Cal.
University of Minnesota	Minneapolis
Wisconsin Academy of Sciences, Arts, and Letters	Madison

MEXICO.

Ministerio de Fomento	Mexico
Observatorio Meteorologico Magnetico Central	Mexico
Observatorio Astronomico Nacional	Tacubaya
Sociedad Científica, "Antonio Alzate"	Mexico
Sociedad de Ingeneiros de Jalisco	Guadalajara
Secretaria de Fomento	Guatemala

ARGENTINE REPUBLIC.

Academía Nacional de Ciencias Exactas	Cordoba
Direccion General de Estadistica	Buenos Ayres
La Museo de la Plata	Buenos Ayres

AUSTRALASIA.—VICTORIA.

"Age"	Melbourne
"Argus"	Melbourne
Athenæum	Melbourne
Astronomical Observatory	Melbourne
Australasian Institute of Mining Engineers	Melbourne
Chief Secretary's Office	Melbourne
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Free Library	Echuca
Free Library	Geelong
Free Library	Bendigo
Geological Society of Australasia	Melbourne
Gordon Technical College	Geelong
Government Entomologist	Melbourne
Government Statist	Melbourne
Medical Society of Victoria	Melbourne
Parliamentary Library	Melbourne
Pharmaceutical Society of Australasia	Melbourne
Public Library	Melbourne
Railway Library	Melbourne
Royal Geographical Society	Melbourne
Royal Mint	Melbourne
School of Mines	Ballarat
School of Mines	Castlemaine
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School of Mines	Maryborough
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University Library	Melbourne
Victorian Chamber of Manufactures	Melbourne
Victorian Institute of Engineers	Melbourne
Victorian Institute of Surveyors	Melbourne
Working Men's College	Melbourne

NEW SOUTH WALES.

Australian Museum	Sydney
Astronomical Observatory	Sydney
Botanic Gardens	Sydney
Department of Agriculture	Sydney
Department of Mines	Sydney
Linnæan Society of New South Wales	Sydney
Parliamentary Library	Sydney
Public Library	Sydney
Royal Geographical Society	Sydney
Royal Society	Sydney
Technological Museum	Sydney
University Library	Sydney

SOUTH AUSTRALIA.

Parliamentary Library	Adelaide
Public Library and Museum	Adelaide
Royal Society of South Australia	Adelaide
University Library	Adelaide

QUEENSLAND.

Parliamentary Library	Brisbane
Public Library and Museum	Brisbane
Royal Geographical Society	Brisbane
Royal Society of Queensland	Brisbane

TASMANIA.

Parliamentary Library	Hobart
Public Library	Hobart
Royal Society of Tasmania	Hobart

NEW ZEALAND.

Auckland Institute and Museum	Auckland
Colonial Museum and Geological Survey Department	Wellington
Museum	Christchurch
New Zealand Institute	Wellington
Otago Institute	Dunedin
Parliamentary Library	Wellington
Public Library	Wellington

WEST AUSTRALIA.

Observatory...	Perth
Geological Survey Office	Perth

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PART I.

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